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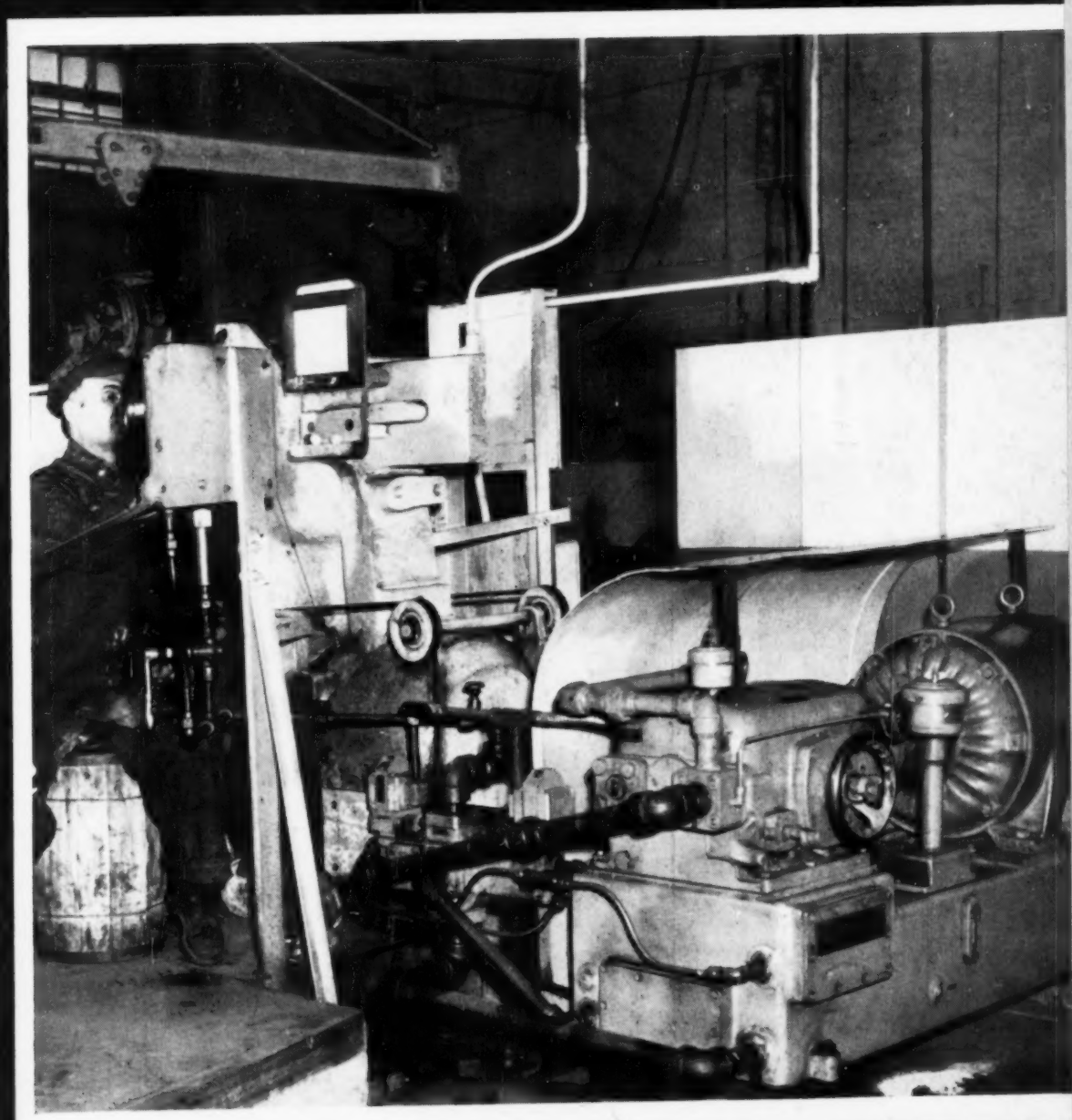
The Magazine of Fluid Power Transmission



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FRONT COVER: The wheel press in the Meadville, Pa., shop of the Erie Railroad after its modernization with a duplex oil pump system. Increased capacity stepped up the press from a bottleneck to a pace setter in the shop. See story, page 20.

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I AM AN AMERICAN

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Even the happy hobo is an example. The open road, the companionship of the "jungle", the backdoor panhandling, and the scrupulous avoidance of work are his choice. Nobody has the right to pop him in jail or chain him to a job. As long as he's an honest hobo, he's free as the air. He's an American too.

On May 15th comes "I Am An American Day". Why specialize on a day? We ought to be whooping it up and cheering hoarsely most of the time. And we *would* if we counted our American blessings . . . all the big and little freedoms won and held for us by sixteen generations of those who went before.

Be in the front row on May 15 cheering "I Am An American" till the rafters ring. Look for me . . . I'll be there.

NON-FLAMMABLE HYDRAULIC FLUID

THE EXTREME IMPORTANCE OF air safety has been emphasized repeatedly by all persons associated in any way with the technical aspects of aircraft. The National Advisory Committee for Aeronautics[1] in summarizing air accidents during 1946 and 1947 has indicated that nearly 100 lives were lost as a result of fires in aircraft during 1946 and a similar high toll during 1947. Steady progress in learning methods for the prevention, detection, confinement and extinguishment of aircraft fires, particularly in flight, has been made during recent years as the result of the leadership and efforts of the Civil Aeronautics Administration and the work sponsored and conducted by the Air Force, the Navy Bureau of Aeronautics, the aircraft and equipment industries, the National Fire Protection Association and the universities.

This problem of fires in aircraft is particularly concerned with the more or less inflammable liquids such as fuels, engine oils and hydraulic fluids. Great efforts have been expended towards the development of non-flammable hydraulic fluids, while relatively little effort is being directed toward reducing the flammability of the hundreds of gallons of fuel and engine oil carried aboard aircraft. Hosterman[2], in attempting to explain this discrepancy, points out that the fuel and engine oil systems are generally located in limited areas; whereas the hydraulic fluid is conducted under high pressure to virtually all areas of the airplane structure and thus the possibility for ignition due to leakage or line breakage is greatly increased.

The military services recognized the need for less inflammable hydraulic fluids as early as 1941 and embarked on a program to investigate the flammability of hydraulic fluids and to develop non-flammable hydraulic fluids suitable for use in aircraft. The most critical military needs appeared to be the development of fluids which would not burn when subjected to gun fire. Great impetus was given the program as a result of a Royal Air Force survey in 1943 which disclosed that, of all combat losses directly attributable to fire, 2 to 3 percent were due to hydraulic fluids. Subsequent surveys by the 8th Air Force confirmed these figures.

The interest of commercial airlines and aircraft companies in this problem began in 1946 as a result of a series of fires, attributed to hydraulic fluids, in the early Constellations. These and subsequent fires seemed to stem from three major sources:

(1) Leakage of fluid onto inflammable materials or onto materials hot enough to ignite the hydraulic fluids;
(2) Contact of electrical and hydraulic lines;
(3) Failure of high speed rotating parts.

As a result of these fires and the potential hazard of currently used hydraulic fluids in aircraft, The Civil Aeronautics Board Safety Bureau issued the Civil Air Regulation Draft Release No. 46-3, dated August 22, 1946 outlining the need for non-flammable hydraulic fluids for aircraft. Since that time the development work of the various industries and government agencies has been accelerated to a point where it appears that a non-flammable hydraulic fluid for aircraft is on the horizon.

Why Hydraulics for Aircraft?

The reader may well ask, "Why use hydraulics in aircraft if the hazard is so great?" As in the case of automotive and industrial equipment, the wide use of hydraulics in aircraft has stemmed from the fact that a relatively simple method is offered whereby large forces may be applied with astonishing accuracy of control. The aircraft design engineer normally has a choice of several methods of approach to the transmission and control of power—mechanical, pneumatic, electrical and hydraulic. His selection is usually based, however, on a combination of performance, reliability and weight. For this reason, on a particular airplane type, the use of all of these methods of power transmission may be used. For example, the bomb bay doors may be operated pneumatically, the brakes hydraulically and the flaps electro-mechanically. The choice of hydraulics in many of the current military and civilian planes has reflected compliance with these basic requirements. Another reason that hydraulics will continue to be used in aircraft where they perform more satisfactorily than other systems is that the fire problem, while potentially a serious hazard, has not been the serious problem the newspaper releases have indicated it to be.

NOTE: The opinions expressed are those of the author and do not necessarily represent the official opinions of the U. S. Air Forces or the Air Material Command.

A REALTY?

By E. M. GLASS
Materials Laboratory
Engineering Division
Air Material Command
Wright-Patterson Air Force Base

Mechanical Redesign Possibilities

As in the case of most lubrication and hydraulic problems, there are always two avenues of approach—the design approach and the fluid or lubricant approach. The latter approach is the one which is usually accepted as most logical and expeditious without too much consideration given to design change possibilities. This has been due, at least in part, to the highly competitive spirit within the petroleum industry which has usually come up with an answer without the necessity for design changes.

Fenske[3] has recommended continuously since 1942 that, in addition to the search for non-flammable hydraulic fluids, more consideration be given to the possible use of non-flammable shrouds and hydraulic fuzes. These recommendations are being examined by the aircraft industry and the military services and the use of shrouds and fuzes in some hydraulic systems or in parts of certain systems may become a reality. As a general method in the control or prevention of fires in all systems, such devices would not be entirely practical due, in particular, to the weight penalties involved. Open center type systems are considered another possible means of controlling the fire hazard. In such systems the pressure is reduced to zero or to low back pressure when no circuit is in use. Military requirements for these systems have been in effect for some time, but are in very limited use due to the following factors:

(1) The extensive use of hydraulic surface control boost and power systems has prevented the efficient use of the open center system;

(2) Back pressures reach 300 to 400 psi in many instances, which could be sufficient pressure to cause a fire under favorable circumstances.

A COMPARISON OF THE PROPERTIES OF USAF EXHIBIT SPECIFICATION AND AMS 3150

REQUIREMENT	USAF EXHIBIT SPECIFICATION	AMS 3150
Effect on present packings	Comparable	Comparable
Compatibility with present fluids	100 per cent	5 per cent
Toxicity	Comparable	Comparable
Viscosity		
at 130 F	9 centipoises (Min.)	.....
at —40 F	500 centipoises (Max.)	a. 2000 centistokes (Min.) b. 7000 centistokes (Max.)
Pour Point	Below —75 F	.....
Low Temperature Stability	Controlled at —65 F	.....
Density	Determined but not controlled	1.1 (Max.)
Coefficient Expansion	.....	No greater than petrolem base fluids
Storage Stability	Comparable	Comparable
Evaporation and Tackiness	Comparable	Comparable
Corrosion (Immersion)	.....	Controlled
Hydrolytic Stability	Controlled	.....
Oxidation Stability	Controlled	.....
Rubber Swell	Controlled	.....
Pump Lubrication	Comparable	Comparable
Power System Performance	.....	Evaluated
Shear Stability	Controlled	Controlled
Volatility	Controlled	.....
Flammability Tests	Comparable	Comparable
Gun Fire	Controlled	.....

TABLE I

Status of Fluid Development

As a result of the wide interest of the industry in the status of non-flammable hydraulic fluid developments, the Society of Automotive Engineers arranged a symposium on this subject at their 1949 Annual Meeting. Papers [2,4,5] and discussions by all segments of industry and government clearly showed how much effort, time and expense has been expended on this problem. While much progress has been made, it was clearly shown that no fluid has been developed to date which fully meets all of the requirements considered necessary by all major users of aircraft hydraulic fluids.

The major reason for this inability to agree on overall requirements stems from the differences in operations among users. The Navy and the commercial airlines appear to be willing and able to sacrifice perform-

PROPERTIES OF NON-FLAMMABLE HYDRAULIC FLUIDS COMPARED TO SPECIFICATION AN-O-366

PROPERTY	AN-O-366	WATER BASE	ESTER BASE	HALOGENATED
Flash Point, F	200	No true flash point	No true flash point	No true flash point
Pour Point, F	—75	—50	—60	—95
Viscosity, in Centistokes				
at 130 F	10	10	15	5.9
at —40 F	500	2000	7000	425
Density	.85	1.06	1.09	1.55
Viscosity, in Centipoises				
at 130 F	8.3	8.4	10.2	8.6
at —40 F	450	3090	7330	760
Corrosion of Metals	Non-Corrosive	Corrodes Magnesium, vapor phase steel	Satisfactory	Satisfactory
Pump Life	Used as reference	Inferior to AN-0-366	Considerably better than AN-0-366	Satisfactory
Effect on Rubber	Present packings OK	Questionable at high temperatures only (above 160 F)	Requires change in rubber	Requires change in rubber
Toxicity	Satisfactory	Satisfactory	Satisfactory	Questionable
Cost per gallon (Approx.)	$1.00	$2.50-$3.00	$12.00	Estimated $8.00

TABLE II

ance of hydraulic fluids to achieve varying degrees of fire resistance. The Air Force on the other hand, has maintained a requirement that aircraft be able to operate from —65 F to +160 F (plus any temperature rise in the equipment) without significant loss in reliability. The present hydraulic fluid, Specification AN-0-366, will permit such operation. Any fluid, even though it is completely non-flammable, non-corrosive, non toxic, inert to rubber, etc., incapable of accomplishing this also could certainly not be considered acceptable by the USAF.

Interim Type Non-Flammable Hydraulic Fluid

The Aircraft Research and Testing Committee of the Aircraft Industries Association has prepared a specification covering an "interim" type non-flammable hydraulic fluid which, in the opinion of the committee, could be developed, tested and produced within a reasonable length of time. This specification has been issued as AMS Specification 3150. The type of fluid defined by this specification would not be a true non-flammable fluid, but only less inflammable than the currently used fluid, Specification AN-0-366. The flammability properties of any fluid are difficult to assess quantitatively and as a result, the ARTC established a reference fluid, HS-1. The degree of inflammability of HS-1 was arbitrarily chosen on the basis of existing base compounds and in the belief that a hydraulic fluid with this degree of fire resistance would have prevented a large percentage of the aircraft fires in which hydraulic fluid is known to have been a primary factor. Secondly, certain compromises in the desired performance as a hydraulic fluid were made in order to achieve the degree of fire resistance defined in the specification.

ARTC Specification for Final Fluid

While the specification for a final fluid, meeting the ultimate in desired requirements, has not been issued to date by the ARTC committee,* it presumably will define a fluid equal in performance to Specification AN-0-366 with the added requirement of a high degree of fire resistance. Such a fluid, however, is not expected necessarily to be suitable for use in current hydraulic systems.

USAF Exhibit Specification

The Air Force has released recently an experimental specification for a less inflammable hydraulic fluid based on development work with halogenated "snuffers" for mineral base stocks or for total ingredients of the fluid. This specification may be described simply as a "less inflammable AN-0-366" with a few added requirements dictated by the necessary use of non-hydrocarbon materials. The flammability requirements are comparable with AMS 3150 with the exception of a gun fire test. The performance requirements are those of Specification AN-0-366. Table 1 shows the differences in requirements of the USAF Exhibit Specification and AMS 3150. As may be seen, the Air Force specification is also in the "interim" class and, since none of the "interim" fluids examined to date appear to be usable in current hydraulic systems without at least a packing change, the Air Force will probably place greater emphasis on the development of a final fluid comparable to that being considered by the ARTC.

Editor's Note: A preliminary draft of a specification was presented at the A-6 Committee Meeting, Dayton, April 7.

Properties of Fluids Reported in the Literature [2, 4, 5, 6, 7, 8]

Let us examine the properties of those fluids which have been publicized in the literature and at the recent SAE symposium. Table II compares the more important properties of the non-flammable fluids to Specification AN-0-366. Table III and Figure 1 will give the reader some idea of the fire resistant properties of the various non-flammable fluids. The data contained in Table III were obtained by the Civil Aeronautics Authority[6] in tests simulating B-29 crash conditions. The data in Figure 1 were reported by Hosterman[2] and were based on a novel and simple test consisting of soaking a pipe cleaner with the test fluid and passing it through a flame at a constant rate. The number of passes made until a self-sustaining flame is produced is recorded. This type of

SIMULATED B-29 CRASH FIRE RESULTS

FLUID	ELECTRIC ARC		SPRAY	ACETYLENE FLAME	
	Stream Between Electrodes	Stream Impinging on Electrode		Stream Through Flame	Spray
AN-0-366	Fire	Violent Fire	Violent Fire	Fire	Violent Fire
Water-Glycol	No Fire	No Fire	No Fire	No Fire	No Fire
Halogenated	No Fire	Very small fire	Very small fire	No Fire	Very small fire

TABLE III

test, while it does not simulate many of the possible ways in which a fluid can be ignited, probably shows better than any other method the overall comparison among the various fluid types.

Navy Hydrolube U-4

The Navy has been committed to the use of water-glycol base hydraulic fluid for some time. The decision to use this type of material was based on detailed studies of a wide variety of materials with only the water-glycol fluids offering any hope of developing fluids suitable for widespread aircraft use in the near future without extensive equipment redesign or change.

The Hydrolube U-4 fluid has been the subject of considerable laboratory and service tests. Flight tests of the fluid have been made in a Grumman F6F fighter, nine Chance Vought F4U-4's and it has been used in F9F's for over a year. The Navy will continue to install this fluid in production F9F's. No serious trouble has been encountered to date in service, although corrosion of magnesium brake pistons did occur, at which time a changeover was made to aluminum brakes. As a result of a recent fire, the Navy is installing the U-4 fluid in a squadron of AD airplanes and, if satisfactory performance is obtained, the use of this fluid will presumably be extended to other squadrons.

The major drawbacks to this fluid appear to be high volatility and inferiority to Specification AN-0-366 in corrosion resistance, lubrication and low temperature performance.

The Navy has realized that water base fluids are not optimum at this particular point in the development, but contends that there are no inherent limitations on the improvements which are possible. Lubrication has been improved greatly and can be improved further. Low temperature viscosities have been improved in experimental fluids and greatly improved corrosion resistance demonstrated in others. It only remains to combine these characteristics into a single balanced formulation and to prove it out under tests.

RPM Non-Flammable Hydraulic Fluid (Fluid A)

After a survey of non-flammable base materials, including water soluble types, ester types, silicone types and halogen containing types, the California Research Corporation concluded that only the halogen types gave promise of complete non-flammability, together with good low as well as high temperature characteristics. Preliminary work on halogenated fluids of the interim type indicated that present system rubber components would be adversely affected. This appeared to be true also for all other interim fluids being examined. Accordingly, development work on a completely non-flammable fluid was intensified with the result that a fluid has been developed which very nearly meets all of the requirements of the final fluids sought by the Aircraft Research and Testing Committee and the Air Force. The principal ingredient of this product is a halogenated non-aromatic hydrocarbon.

The flammability of this fluid as determined by the Technical Development Service, Civil Aeronautics Administration[6] indicate it to be almost equal in ignitibility under simulated B-29 crash conditions to Hydrolube, which is practically not ignitible under these conditions of tests (See Table III).

The shortcomings of this fluid appear to be its high density, its questionable toxicity, failure to meet fully Air Force low temperature requirements and a requirement for

(Continued on page 22)

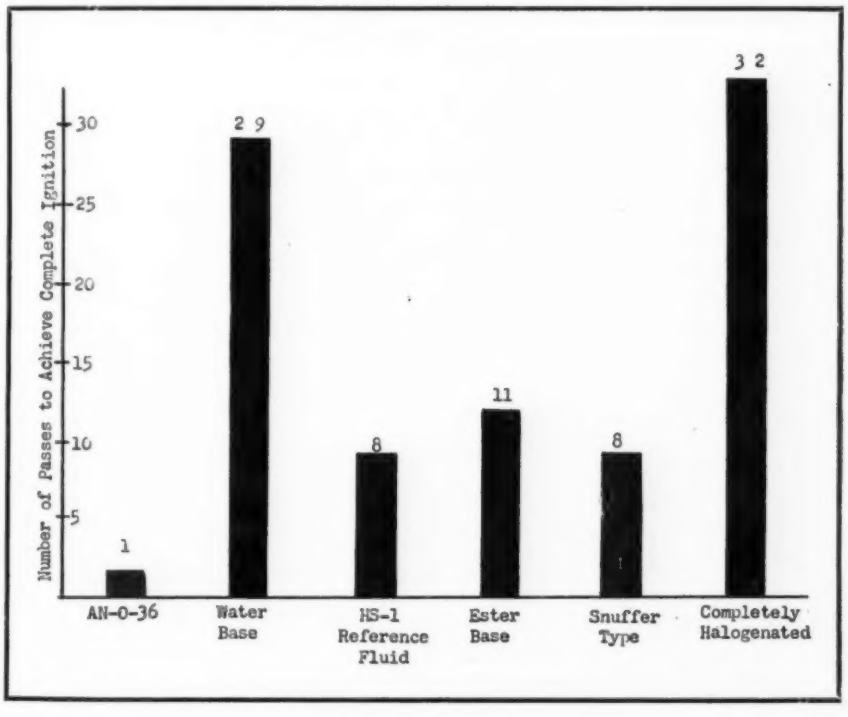


Fig. 1. Relative fire resistant properties of non-flammable fluids with AN-0-366 as a index.

Fig. 1. The water booster with diaphragm operated three-way valves on the high pressure side, air type valves on the low pressure side. The three-way valves connect the 1700 psi lines to the rear of the cylinders, admitting this pressure alternately. The front ends of the cylinders are connected through check valves with the 2500 psi outlet line.

—STEPPING UP WATER PRESSURE

By RUPERT P. ESSER
President
Tec Engineering Corp.
Logansport, Ind.

The design of a high pressure water booster which enabled a molding company to close presses at pressures greater than that carried in the plant system. By utilizing standard high pressure water valves, air valves on the low pressure side and two special cylinders, a 1700 psi pressure was stepped up to 2500 psi—increasing production and improving quality of parts.

IT IS A COMMON PRACTICE IN MANY plastic and synthetic rubber molding companies to utilize both low and high pressure central water piped throughout the plant. When such plants needed pressures greater than those carried by their high pressure lines to close a number of their multi-cavity mold presses at optimum rates, they were not able to get maximum production from such presses. We were able to contribute to the solution of such a problem for one of our customers by building and installing high pressure water boosters or intensifiers, connected with and operated by the present low and high pressure systems.

Our customer, a molding shop in Goshen, Indiana, was faced with reduced production since their plant high pressure system carried only 1700 psi, while a number of their presses needed 2500 psi closing pressure for efficient production. In addition, the 200 psi low pressure water presented a difficulty. While there are several designs of continuous running oil intensifiers on the market, no one, apparently, was interested in making an intensifier for raw water service.

The basic original idea for these high pressure water boosters was conceived by the chief engineer of the molding company. After analyzing the problem with him, we recommended that the standard high pressure water valves of one manufacturer and the air control valves, suitable for low pressure water service, made by an affiliated company be used with special cylinders to fit the job.

Because at least one manufacturer had turned the job down previously and the considerable production loss was continuous, we were authorized, on the basis of our preliminary design, to go ahead.

In order to get a reasonably even flow of high pressure water which is necessary to maintain pressure in the molding presses during the curing time and to provide for leakage (which sometimes may be considerable) past the press plunger packing, we decided to use two cylinders.

We selected a bore size and rod size which would give us the same ratio between the effective area on the blind end of the cylinder and the rod end of the cylinder as the ratio between the incoming 1700 psi and the outgoing 2500 psi. The cylinders were made of centrifugally cast, close grained iron, honed accurately to a very smooth finish, with bronze pistons and chrome plated piston rods. We used "O" rings on the static cover seals as well as on the piston and rod seal.

Due to the high pressures involved, we used leather back-up washers on either side of the "O" ring on both the piston and the rod packing to prevent extrusion under high pressure. Standard oil seals were incorporated in the front covers to act as wipers to keep the rods clean. A circular cam disc was attached to each piston rod for operating the ¼ in low pressure pilot valve. The two piston rods are not connected with each other, thus eliminating difficulties in aligning.

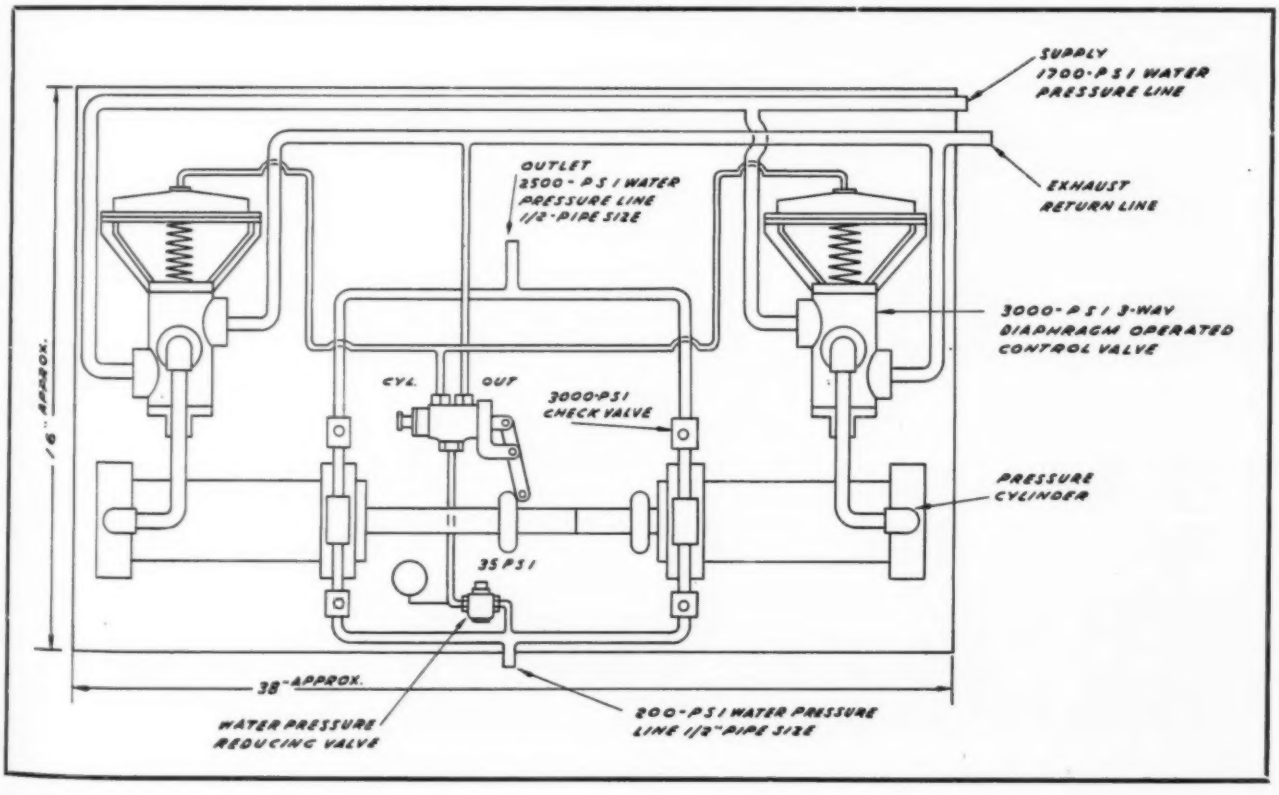
As shown on both the photograph of the intensifier and the diagram, Figures 1 and 2, the unit has four connections. One of these is for the incoming 200 psi line, which prefills the cylinders and returns them to their retracted positions through check valves. This 200 psi line is reduced through a water service reducing valve to 35 psi, since the diaphragms of the master valves should not be subject to over 35 psi pilot pressure. The 1700 psi main pressure line is connected through the two diaphragm operated three-way valves with the rear ends of the cylinders and admits this pressure alternately to one or the other cylinder. The front ends of the cylinders are connected through high pressure check valves with the 2500 psi high pressure outlet line. The exhausts from the two high pressure valves and the low pressure pilot valve are connected with a common return line.

In the position shown in the diagram, Figure 2, the 35 psi pilot pressure is blocked by the lever operated, three-way water valve which connects both diaphragm tops with exhaust so that both three-way valves are in the upward position. Therefore, the 1700 psi supply pressure is admitted to the rear end of the right cylinder, creating 2500 psi pressure on the rod of the right cylinder. This pressure is discharged through the check valve to the press as required.

Since the left three-way valve is also in the top position, the rear side of the left cylinder is connected with the exhaust and the 200 psi low pressure supply enters the rod side of the left cylinder, moving it to the left. When the right cylinder completes its stroke as it delivers high pressure water, the cam disc on the right piston rod reverses the three-way pilot valve, which then admits 35 psi pilot pressure to both diaphragm tops. We then have 1700 psi going to the rear end of the left cylinder, which now acts as an intensifier, while the rear end of the right cylinder is connected with the exhaust until the three-way pilot valve is shifted again.

The first of these high pressure water intensifiers has been in operation for over four months. Maintenance has been low. The original idea has been proven practical. The step up of pressure to 2500 psi is closing presses at an optimum rate and maintaining maximum production and has resulted in better parts because the extra pressure is available when needed.

Fig. 2. Diagram of the booster circuit.



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LETTERS to the Editor

Congratulations on the start of the series "A Beginner's Course in Basic Hydraulics". Although not quite a beginner in this field, I must say that these articles will prove to be very worthwhile reading if they continue to be written in the same manner as the first was.

C.J.C.

Thanks, and except for an unfortunate error (see comments elsewhere in this column), we believe a great many of our readers agree with you.

Can you recommend a good text on practical applications of mathematics between the basic trade school texts and the treatises on engineering mathematics? The first don't go far enough, the second are too theoretical (that means too tough for me) to be useful.

V.R.

There are several such texts, one recently published, that might be what you are looking for. We are sending this information to you.

We have had a number of our readers write us regarding the error in the first article of "A Beginner's Course in Basic Hydraulics" (Figure 2, page 8 and accompanying description, pages 8 and 10, March issue). We corrected this in our April issue, page 33.

Our faces were very red in the editorial department when the letters, cards and diagrams putting us straight began to come in. While our source was above reproach, we admit the fault was ours since we did not check the figure and text carefully enough. We wish to thank the designers, engineers, maintenance men, technical schools and others who took the trouble to write us.

Because of its importance at the beginning of the series we are repeating the correction. The pressure and area relation in the hydraulic analogy part of Figure 2 are reversed. The 100 pounds should be over the larger, left area, the 50 pounds over the smaller, right area. The text (last paragraph on page 9 and runover to page 10) repeats the error of the diagram. The last sentence of this paragraph should be corrected to read ". . . so in hydraulics a force of 50 pounds applied over a certain area can balance a force of 100 pounds acting over *twice* that area."

We promise more careful editing on subsequent installments.

We have been looking into the problem of a starter for an engine which drives a large portable compressor that operates through the winter.

(Continued on page 18)

THEY FLOAT!

WHAT: *bearings in a Pesco Hydraulic Pump*

WHY: *to constantly maintain minimum end clearance*

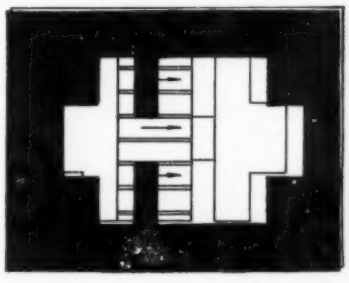
HOW: *by means of "PRESSURE LOADING"*

RESULT: *volumetric efficiencies up to 97%*
. . . torque efficiencies up to 90%

"Pressure Loading" is an exclusive, patented Pesco principle of construction for gear type hydraulic pumps. By *automatically* holding end clearance to a thin film of oil, maximum torque and volumetric efficiencies are obtained under all operating conditions. New pump efficiency is maintained throughout the long service life of the pump since "Pressure Loading" provides an *automatic* take-up of wear.

THIS IS "PRESSURE LOADING":

The schematic illustration at right shows the three principal parts of a gear type hydraulic pump. They are the bearings ("A" and "C") and the gear ("B"). Bearing "A" is fixed. Bearing "C" "floats". By means of the "Pressure Loading" principle, pressure from the discharge of the pump is transmitted through a "pressure loading" passage and is exerted against the rear of the "floating" bearing (arrows). This force is counterbalanced by the pressure developed within the gear cavity so that the thrust of the bearing against the gears is just enough to accomplish its purpose.



REMEMBER: *Only Pesco Hydraulic Pumps are "pressure loaded"!*

If your product uses, or can use the sales power of hydraulic power, be sure to get the full story of "Pressure Loading" and what it means to the efficient, economical operation of your product. Write for the booklet "Pressure Loading by Pesco". There is no obligation.

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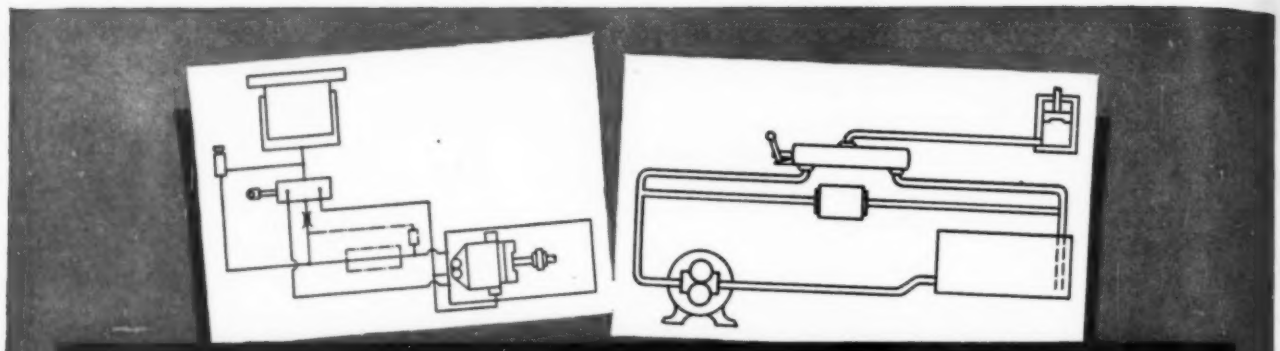

A Beginner's Course in Basic Hydraulics

Part III Introduction

What atmospheric pressure is and how the partial vacuum is utilized in the operation of a hand pump; the relation of input and output forces; the interchangeability of the forms of energy.

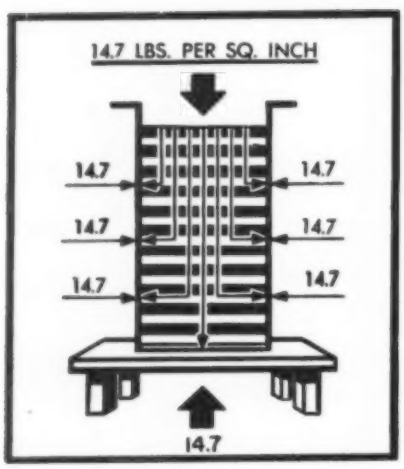

Fig. 16. Pascal's law is obeyed identically with atmospheric pressures as with liquids. The atmospheric pressure being balanced, the liquid is at rest.

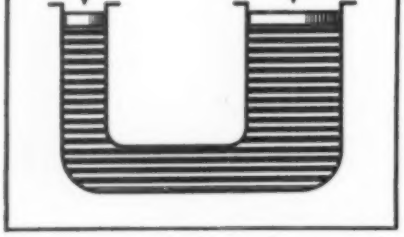

Fig. 17. Since atmospheric pressure exerts an equal pressure per unit of area on both pistons, the pressures exerted on the pistons are in balance.

Atmospheric Pressure

Acts like other forces. Up to this point we have ignored the fact that all of the hydraulic systems we have discussed are literally bathed in air. Everything on the surface of the earth exists at the bottom of an ocean of air extending upward many miles into space. Even when a plane is flying at a great height it has ascended only a small way towards the point where the density of our atmosphere approaches zero.

Since the air in which we live is a mixture of gases—that is to say of material substances—it has weight and therefore exerts pressure by virtue of head. Although any small volume of air weighs very little, the pressure at sea level under standard conditions amounts 14.7 pounds per square inch.

Since gases are compressed by their own weight, the same volume of air at sea level will weigh considerably more than on a mountain top and still less at higher altitudes. In addition, gases expand as their temperature rises, so that an equal volume of gas at a higher temperature will weigh less than at a lower temperature.

How, then, is it possible to ignore a pressure of 14.7 pounds on every square inch of our body surface, as well as on the hydraulic systems we are studying? The answer is simple. Atmospheric pressure is balanced either by itself or by the resistance of bodies strong enough to withstand it. Whenever this is not the case, we have an unbalanced force.

Atmospheric pressures, in other words, obey Pascal's Law no less than do pressures, set up in liquids. Just as in Figure 5, which illustrated that pressures due to liquid head must balance at every point in every direction if the liquid is to remain at rest, atmospheric pressures balance. It makes no difference even with the thinnest surface or through liquids, as long as the pressure balances. For example, a sheet of paper is not torn by atmospheric pressure, as it would be by an unbalanced force of 14.7 psi, because atmospheric pressure acts equally on both sides of the paper. In Figure 16 atmospheric pressure acting on the surface of the liquid and transmitted equally

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throughout the liquid to the walls of the container, is balanced by the same pressure acting directly on the outer walls of the container. In Figure 17 atmospheric pressure acting on the surface of one piston is balanced by the same pressure acting on the surface of the other. The different areas of the two surfaces make no difference, since pressures for a unit of area are in balance.

Only if the difference in level of the two surfaces in Figure 17 was very great would the difference in atmospheric pressure produce an appreciable head of liquid.

Vacuum and partial vacuum. When you suck soda through a straw you pull some of the air from the straw and disturb the balance of pressures prevailing in the glass. Unbalanced atmospheric pressure acting on the surface of the liquid pushes soda up into the straw. The motion of the liquid will continue until a new balance is reached. The soda can be held at a certain level in the straw. This level will be that at which the pressure of the head of liquid exactly equals the difference between the pressure in the straw and that on the surface of the liquid (Figure 18). If you take the straw from your mouth, the soda in the straw is subject to the same pressure as the surface of the liquid, and it falls back into the glass.

You have produced a *partial vacuum* in the straw—a pressure, *less than the prevailing atmospheric pressure.* The theoretical limit of this process would be a condition of zero pressure—a complete vacuum. In actual practice, however, it is impossible to produce a complete vacuum.

The hand pump. Water is raised from a well by means of a hand pump by producing a partial vacuum in the flow pipe (Figure 19). The pump handle is attached to a piston in which is mounted valve 1, which swings open as the piston is lowered. Farther down the pipe is valve 2. When the piston is raised, valve 1 closes and the water held above it is carried up the pipe with the piston. A partial vacuum is produced in the space between the bottom of the piston and valve 2 in the cylinder, so that the pressures on the two sides of valve 2 are unbalanced. The greater force on the under side of the valve, due to atmospheric pressure transmitted through the liquid up the pipe, opens valve 2; water enters the cylinder above the valve, where it is trapped by the closing of valve 2 during the downward movement of the piston. In this way, water is forced into the space above valve 2 during the upward movement of the piston, and is admitted into the space above the piston during the downward movement. On the next upward movement of the piston water is carried to the exit spout.

If a perfect vacuum could be produced, the head between valve 2 and the surface of the liquid could be 34 feet at sea level, since a 34-foot head of water produces a pressure of 14.7 psi. Under actual working conditions, however, about 25 feet is considered a satisfactory lift for a water pump. For an oil pump it would be greater since the specific gravity of oils is less than that of water.

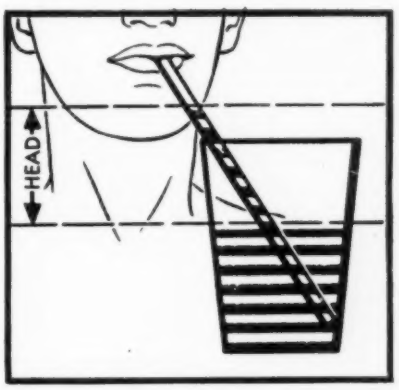


Fig. 18. The partial vacuum sets up an unbalanced atmospheric pressure—the head of the liquid in the straw representing the difference in pressure between that in the straw and that on the surface of the liquid.

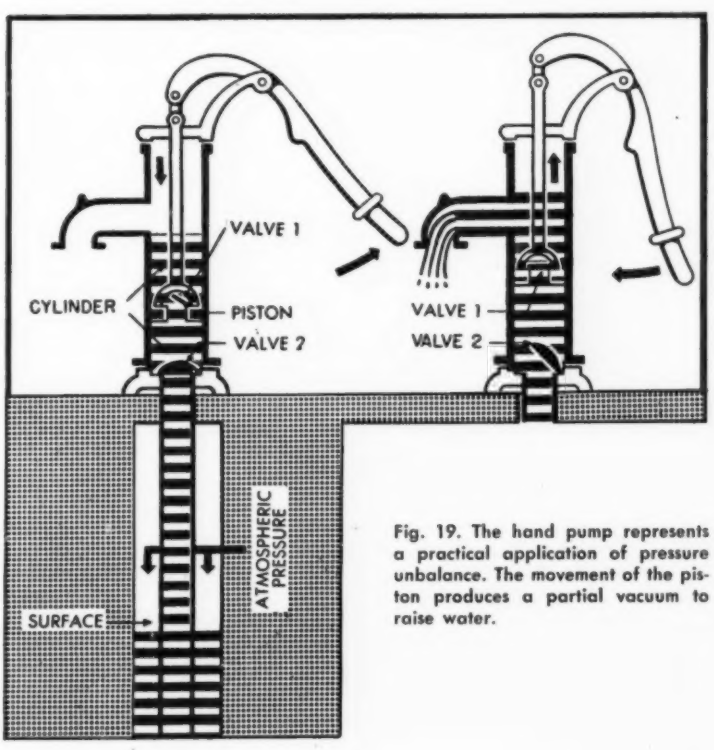


Fig. 19. The hand pump represents a practical application of pressure unbalance. The movement of the piston produces a partial vacuum to raise water.

Input and Output Relations

Equality of work input and output. In our consideration of the hydraulic jack (Figure 14), we found that an increase in output force over input force was accompanied by a decrease in the distance moved in exactly the same ratio. An increase in force can be obtained only by a proportionate decrease in distance moved. This is also true if we operate in the reverse direction: a distance increase can be obtained, but only at the expense of a force decrease in the same ratio. This leads us to the basic statement that, *neglecting friction, in any hydraulic system (or any other mechanical system) the input force multiplied by the distance through which it moves is always exactly equal to the*

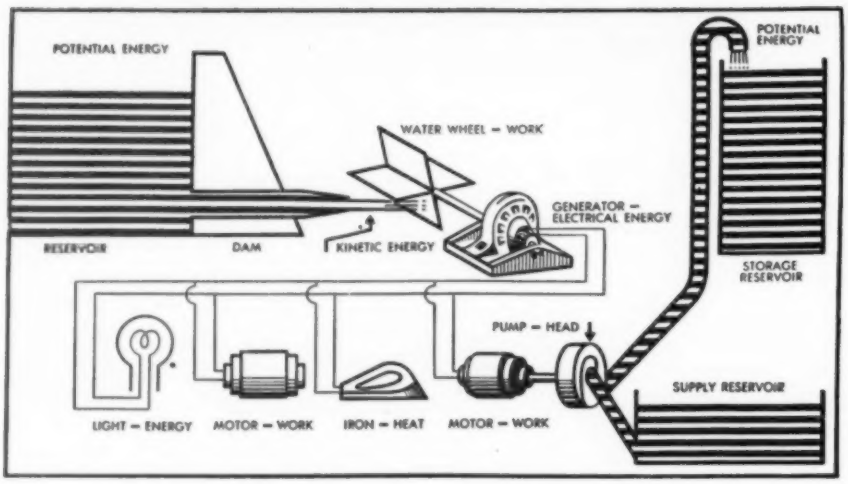


Fig. 20. This schematic diagram of a hydro-electric plant shows a number of forms of energy and their interchangeability.

output force multiplied by the distance through which it moves.

Work and energy. We must now explain two new terms—*work* and *energy*. The scientist defines work as a force moving through some distance, and *the amount of work done is the product of the force multiplied by the distance through which it moves*. Therefore the rule just stated means that, when friction is neglected, the work output is always equal to the work input. Energy is a somewhat similar but broader term. Energy includes work and in addition *all forms into which work can be converted or which can be converted into work*. Work always involves actual movement, but energy can be at rest and still exist as energy, so long as it is capable of doing work. Work and energy are always mutually interchangeable.

In our study of the hydraulic jack we neglected the subject of friction for the sake of simplicity. However, it is well known that there is always some friction in actual machines. It is also known that heat is produced whenever work is done against friction. Therefore, heat is a form of energy because it can be produced from work. Likewise, heat in the form of fire under a boiler can be converted into work through the medium of a steam engine. Now we know that in practice friction represents a loss of efficiency, but this does not mean an annihilation of energy itself. It means only that some of the energy put into the system has been converted into another form which is not useful for the problem at hand. The energy is not usable or available, but it still exists as dissipated heat.

Any work or energy added to the system must, in turn, come from somewhere else, for it is never possible to create or destroy energy. All that can be done is to change it from one form into other forms, forms that make it more or less applicable to the purposes in hand. In the case of an actual hydraulic jack, since there is always some friction both within the liquid and between adjacent parts, the *useful* work output will not exactly equal the work input; the difference will always exist somewhere in some other form of energy. In this case it will appear as heat. In other words, while the usable work output does not equal the input, *the total energy output in all forms will always exactly equal the total energy input.*

Energy can exist in a great many different forms, but they all have one thing in common; they are all interchangeable with each other and with work. The many forms which energy can take and their interchangeability is illustrated by a hydro-electric plant. This is shown schematically in Figure 20. A body of water is held back by a dam. The impounded water represents *potential energy*, because it is not doing work at the moment but is capable of doing work if released. If an opening is provided, water will rush out in a high velocity jet, representing energy of motion or *kinetic energy*. If this jet is played against the blades of a water wheel it will push them around producing a continuous rotary motion. This is work in its true sense because a force is moving through a distance. The water wheel can in turn be connected to an electric generator which converts the work into electricity. This electricity can in turn be converted back into work by the use of an electric motor. Or it can be converted into light by the use of an electric bulb or into heat in an electric iron. By means of a motor and a pump we could even transform the energy all the way back into its original form of potential energy existing as a body of water at an elevation. Thus all of these forms of energy are interchangeable with each other. In actual mechanisms there is always some loss in the form of friction producing heat at every exchange, but the total energy, useful and wasted, will always add up to the original energy input.

Review questions for Chapter 1 are to be found on page 36.

The June installment will begin a study of liquid flow. Save each installment for reference.

LETTERS TO THE EDITOR

(Continued from page 14)

Have the several air and hydraulic starters now on the market been completely tested under operating conditions or impartially by a laboratory? Our experience is that, outside of some developments for aircraft engine starters, manufacturers do not seem very much interested.

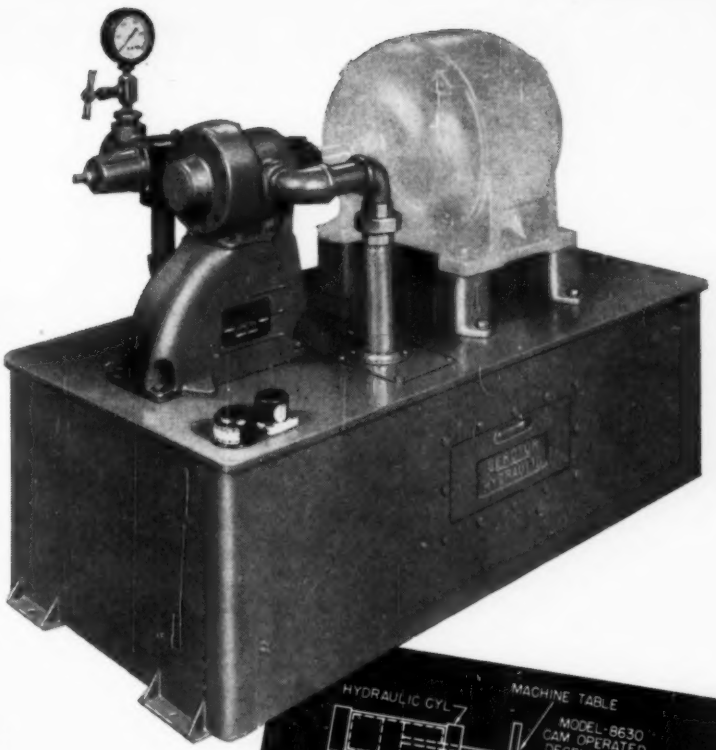
J.D.P.

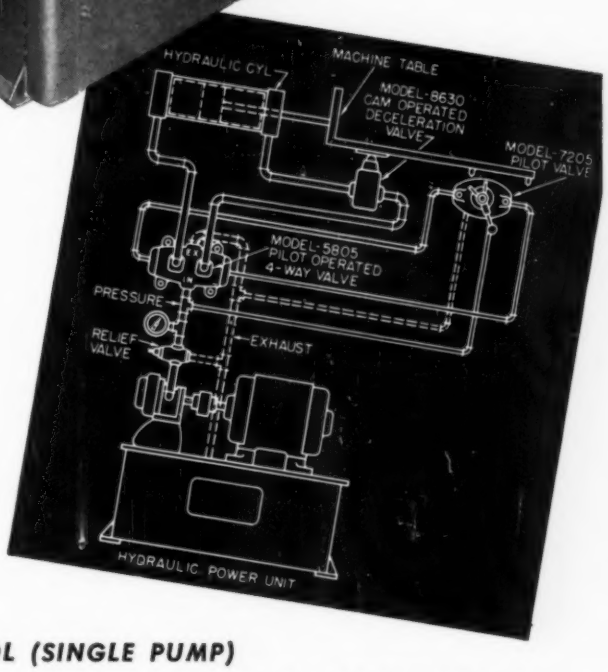
To our knowledge no one user or potential user of air or hydraulic starters has made comprehensive tests of competitive equipment. We have no way of learning the extent of tests being conducted by leading research or commercial test laboratories. We do believe, however, that a number of manufacturers are very much interested in simplifying and perfecting units already on the market or being readied for the market and that others are interested to the extent of pushing design and testing programs. The recent increased interest in air systems for aircraft has stimulated the engineering and production plans of a number of manufacturers of components and compressors. Recently for example, a high speed air turbine starter for jet or turbo jet aviation engines was announced. Manufacturers can supply data on both air and hydraulic starters on request.

YOU GET A

Complete Package

-with a GEROTOR POWER UNIT

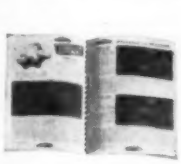




Gerotor offers the Series 9100 Pump Unit as the ideal source of power for your hydraulic circuit. In addition to the highly efficient Gerotor pump, the unit is equipped with relief valve, oil filter, pressure gauge, and all equipment to furnish a steady flow of oil at continuous working pressures up to 1000 P.S.I. Reservoir is available in 5 tank sizes, with pump capacities from .4 G.P.M. to 40 G.P.M. Motor mounting may be arranged for any standard frame. Gerotor double pumps are supplied for installations of two separate circuits.

REMOTE PILOT OPERATED CONTROL (SINGLE PUMP)

Starting the electric motor results in the continuous reciprocating of the cylinder rod. In one position of the Model 5805 Pilot operated 4-Way valve, oil is directed from the pump to the blind end of the hydraulic cylinder, causing the cylinder to extend at its rated speed. When the machine table advances to where it depresses the cam of Model 8630 flow control valve, the forward speed of the cylinder is affected by the setting of the flow adjusting screw of Model 8630 valve. In the other position of Model 5805 valve, oil is directed from the pump to the rod end of the hydraulic cylinder causing it to retract at full rated speed. In this direction of cylinder movement, Model 8630 has no effect on the speed of the cylinder. Model 7205 Pilot valve provides for remote hydraulic operation of the main 4-Way valve, Model 5805. The forward, or return stroke of the cylinder may be manually interrupted at any time by reversing the handle of the Model 7205 Pilot valve.



Write for Catalog Section G-105 showing specifications and description of Gerotor Hydraulic Pump Units.

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WHEN YOU APPLY HYDRAULIC OR AIR POWER *Plan with*

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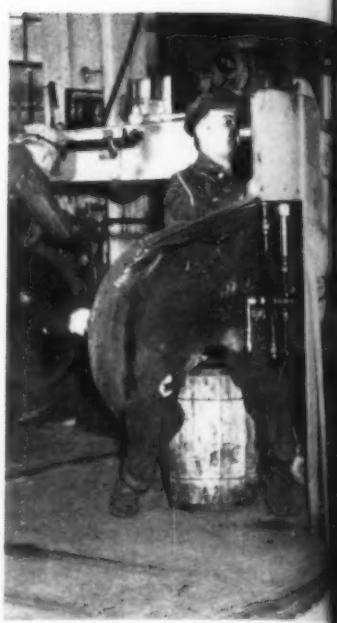
AIR AND HYDRAULIC VALVES AND CYLINDERS, HYDRAULIC PUMPS, MOTORS AND PUMP UNITS

Smoothing Out A

How a railroad repair and maintenance shop smoothed out operating difficulties of a wheel press by replacing an old water system with a duplex oil system. Advantages included easier and more accurate control, faster production and lower operating and maintenance costs.



EQUIPMENT IN A RAILROAD MAINtenance and repair shop is expected to operate year after year with only negligible maintenance. We want it to be simple and fool-proof as possible and have a long life of accuracy.

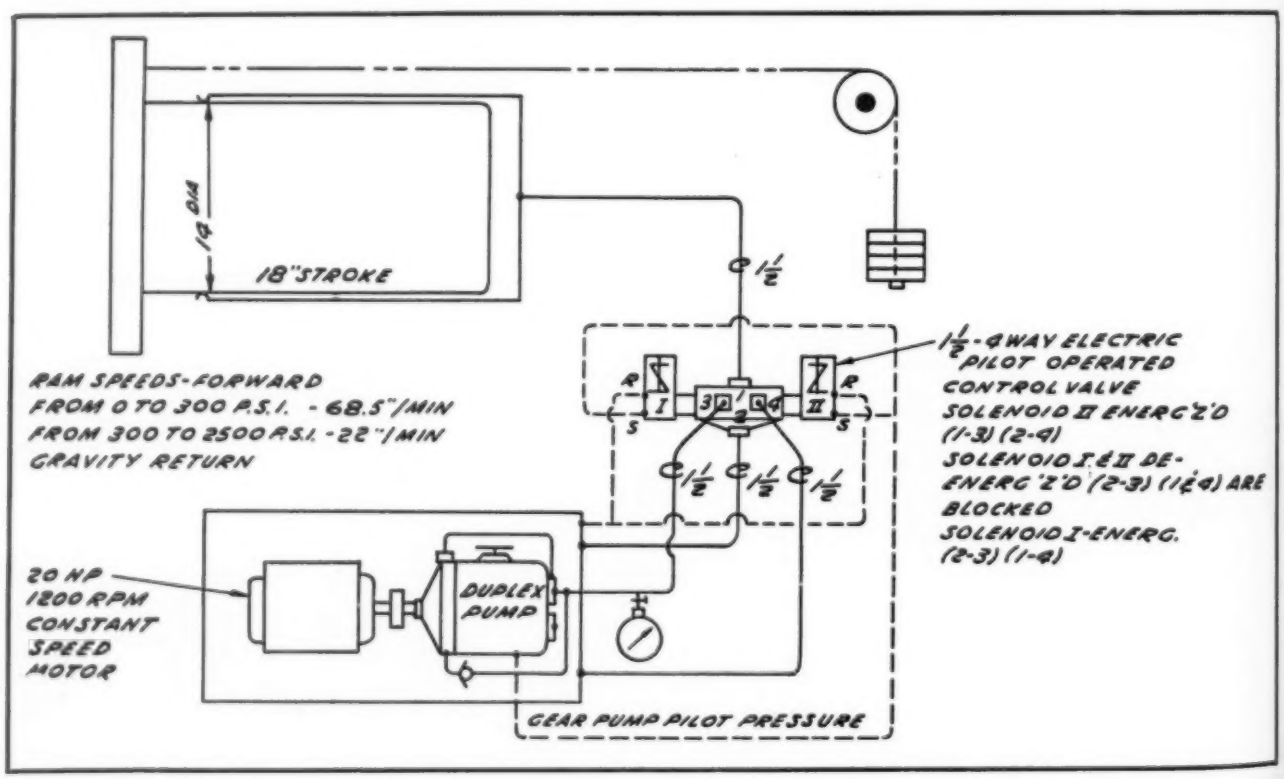
The fact that such equipment is massive does not mean that precision performance can be sacrificed. By precision performance we mean measurements to a thousandth of an inch. A wheel press in our Meadville Wheel Shop is a case in point.

Our wheel press is used to mount steel or cast iron wheels on axles. Mounting is the final production operation in the Wheel Shop before the wheel sets are shipped to various points along the Erie's 2229 miles of track for application, as required, to the many types of rolling stock. Failure of the wheel press to operate efficiently created a bottleneck in the shop's production.

In the mounting operation, wheels are gauged to the proper distances from the longitudinal center of the axle. In order to reduce friction and eliminate wear to wheels and rails, it is necessary to gauge the wheels to the thousandth of an inch.

The wheel press was originally equipped with a water hydraulic system, utilizing a triplex, single-acting high pressure pump. The photograph, Figure 3, shows the press before the re-design. A crew is preparing the wheels and axles for mounting. The mounting of wheels on the axles was often inaccurate due to the pulsations of the triplex pump. Then,

Fig. 2. The circuit of the new oil system on the wheel press.



ESSING PROBLEM

By C. A. KOTHE
Shop Superintendent
Erie Railroad
Meadville, Pa.

Fig. 1. The wheel press in the Meadville shop of the Erie Railroad after its duplex oil pump was installed. The press once a bottleneck, had its production stepped up approximately 33 percent.

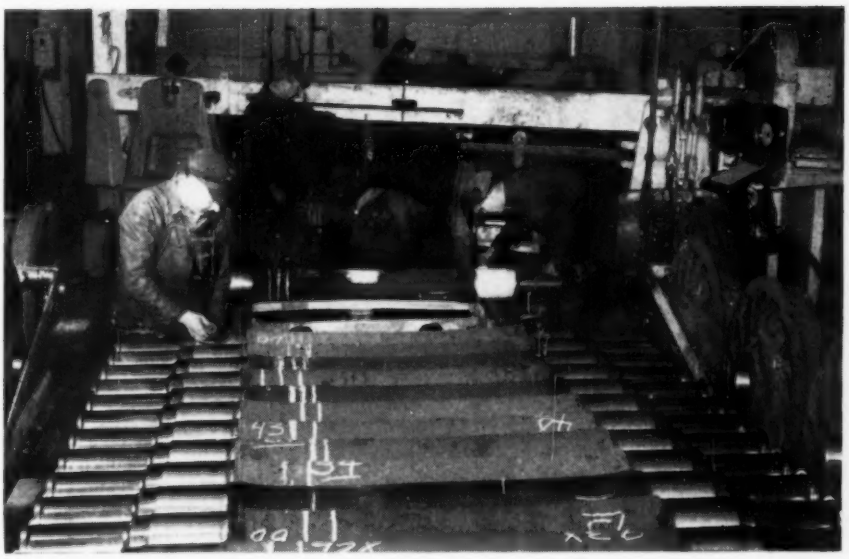


Fig. 3. The front of the wheel press before modernizing, showing a crew preparing axles and wheels for mounting.

too, the operating lever on the pump was inconvenient to the man doing the gauging operation. He had to signal a second man who operated the control lever and followed the signal of the first man.

When the Wheel Shop was moved from Hornell, New York, to a more centralized location in a modernized structure in Meadville, approximately 15 months ago, certain disadvantages in the wheel press were greatly amplified. With material moving through a streamlined production flow pattern in the new building, the shop's output was slowed down at the final operation. Advantages of the latest type lathe, boring mill, inspection and material handling equipment outdated the wheel press.

Here are some of the disadvantages which we encountered: With the water hydraulic triplex pump it was found that dirt frequently lodged in one of the valve seats. The location of the pump (Figure 3) accentuated this difficulty. Lodged dirt threw the entire pump out of balance. Failure of one of the pistons to function properly threw the load on the other two pistons and resulted in uneven pressing of wheels. In addition, there was a great deal more maintenance connected with the old system as compared with the present oil system, which has required only an oil change once every six months.

Before the press was re-designed, it was not unusual for the wheel press to be down for approximately eight hours per week. In addition to the production lost during such periods, more handling was required for the wheels and axles which had to be stored until the press was repaired. This created a housekeeping problem as bored wheels were piled in aisles.

We had the problem of either replacing the wheel press entirely or of modernizing it to keep pace with the shop's production. Our own engineers and those of a leading hydraulic pump manufacturer worked together on the problem. We decided, on the basis of performance, to replace the water hydraulic system with an oil system, shown schematically in Figure 2.

A variable and constant displacement duplex pump, Figures 1 and 4, consisting of a high pressure, variable displacement pump of multi-radial piston design with 3400 cubic inches per minute (14.7 gpm) maximum displacement at a normal pressure of 2500 psi (3000 psi peak pressure), and a low pressure gear pump with a 7000 cubic inch displacement, which gave a total maximum capacity of 10,400 cubic inches per minute (45 gpm) at 300 psi, was selected. An automatic unloading valve, integral with pump, protects the high volume low pressure pump from overload. A high pressure relief valve, also an integral part of the pump, protects the radial piston type pump from overloads.

Figure 4 shows the compactness of assembly. The pump and motor base serves as the oil reservoir. The unit was furnished complete with an oil filler strainer and oil bath type air

filter, sight gauge and manhole covers for cleaning the oil reservoir.

The directional control valve is a 1½-inch electric pilot-operated four-way balanced control valve, supplied with two solenoid-operated pilot end-heads and spring centered. The plunger function of this valve is a by-pass type to relieve the pump in the neutral and block the press in any intermediate return position.

This control valve is mounted and piped at a convenient location with relation to the press cylinder and pump, while the pushbutton control is located conveniently for the operator above the machine frame at the mounting center position. It is possible for one man to do the gauging and control the pressing operation. As an extra convenience, the push-button control can be either hand or foot operated.

Operation of the wheel press with the new oil system has attracted the attention of other companies in the railroad industry with similar problems.

The wheel press has stepped up from a bottleneck to a pace setter in the shop. Operated by the same number of men required by the press with the water hydraulic system, production has been increased by approximately 33 percent.

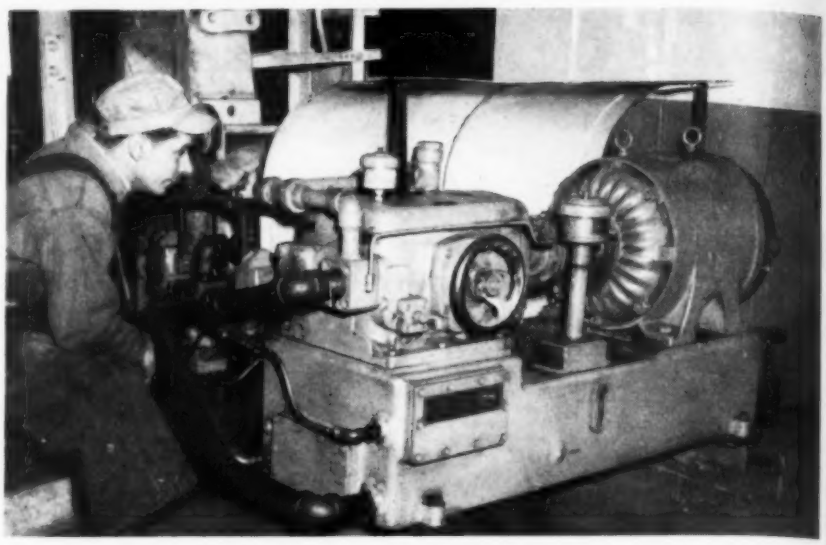


Fig. 4. The compact oil system assembly as installed at the end of the wheel press.

The pressing operaton is more easily controlled with the new oil system. The operators have reported that greater accuracy in mounting to minute measurements is now possible. This accuracy and ease of control has eliminated time lost in close gauging as well as correcting errors in gauge which were previously caused by uneven pressures.

With the press keeping up or exceeding production in other parts of the shop, housekeeping has been facilitated and handling of materials reduced. These factors contribute to efficiency and economy of operations in the Wheel Shop. Once out-dated, it is now our feeling that the wheel press is more modern than other equipment in the year-old shop.

NON-FLAMMABLE FLUIDS

(Continued from page 11)

new rubber packings. These items as well as corrosion in long term usage have not been fully evaluated, however.

Ester Base Fluids

Ester base fluids such as the one developed by the Douglas Aircraft Company and marketed by the Monsanto Chemical Company were developed to equal the performance characteristics of obsolete Air Force Specification 3580, which is being used by a large number of the commercial airlines at the present time. This fluid is of the interim type, meeting most of the important requirements of AMS Specification 3150 and, as in the case of most ester type materials, offers exceedingly good pump life. The flight test phase of the development program is now in progress in a DC-6 cabin supercharger. To date the fluid has accumulated many hundreds of hours of flight time with no indications of difficulty.

The major drawbacks to this fluid are its adverse effects on standard hydraulic fluid packings and its relatively poor low temperature properties. It is indicated[5], however, that intensive development will result in an improvement in the low temperature properties and fire resistance to a point acceptable to the military services and the ARTC Committee.

Future Trends

As can be presumed from the previous remarks, considerable progress has been made in the development of fire resistant hydraulic fluids. It is, of course, regrettable that there is no single fluid available today which meets all of the necessary, and often contradictory, requirements of all of the users of these fluids. In certain classes of compounds improvement of the low temperature properties means greater inflammability, and in other cases, improving the rubber swell characteristics of a formulation results in poorer low temperature properties. It appears apparent at this time that the development of an interim fluid capable of being used in present aircraft hydraulic systems without design or component change is at least complicated, and possibly as distant as the ultimate goal of the final fluid desired by both the ARTC and the USAF. Unless each user tempers his choice with consideration of overall implications, the entire non-flammable hydraulic fluid picture could result in anarchy with airlines and in the military services being required to service individual airplane types with non-interchangeable fluids.

Certainly there are vital decisions facing the entire aircraft industry and the military services at this time. The question of toxicity will have to be answered on a practical basis or some of the more promising classes of completely non-flammable fluids may have to be eliminated. The effect of high density on the economic aspects of commercial aviation and the tactical aspects of military aviation must be assessed; the necessity for redesigning hydraulic systems to offset the loss in reliability as a result of pressure peaks and surges caused by inertia effects must be evaluated. Finally, the user must

choose one of the following:

(1) Institute the use of an "interim" fluid requiring a packing change with the possibility of a second packing change when a final, completely non-flammable fluid is developed;

(2) Institute the use of an "interim" fluid necessitating a packing change with the understanding and requirement that any final fluid accepted would have to be compatible with the packings used with the "interim" fluid; or

(3) Await the development of a final fluid before making any change.

Whatever the final decision, it is believed that every conceivable factor will be taken into consideration by the aircraft industry, the commercial airlines and the military services with only one possible outcome—a real step forward in the program to eliminate actual and potential hazards in aircraft.

References

1. Anonymous, *"Preliminary Survey of the Aircraft Fire Problem"*, Research Memorandum No. E8B18, Cleveland Laboratory Aircraft Fire Research Panel, Flight Propulsion Research Laboratory, Cleveland, Ohio, NACA, May 21, 1948.

2. Hosterman, F. O., *"Evaluation of Non-Flammable Hydraulic Fluids"*, SAE Preprint of Paper presented before the SAE Annual Meeting, January 10-14, 1949.

3. Private correspondence between Dr. M. R. Fenske, Petroleum Refining Laboratory, Pennsylvania State College and the Air Material Command, Wright-Patterson Air Force Base.

4. Farrington, B. B.; Furby, N. W.; and Stockely, J. M., *"A Completely Nonflammable Aircraft Hydraulic Fluid"*, SAE Preprints of Papers presented before the SAE Annual Meeting, January 10-14, 1949.

5. Moreton, D. H., *"Development and Testing of Fire Resistant Hydraulic Fluids"*, SAE Preprint of Paper presented before the SAE Annual Meeting, January 10-14, 1949.

6. Hansberry, H. L., *"Civil Aeronautics Administration Aircraft Fire Prevention Developments"*, Preprint of paper presented before the SAE National Aeronautic Meeting, October 2-4, 1947.

7. Glass, E. M., *"What the Air Force Wants in Nonflammable Hydraulic Fluids"*, SAE JOURNAL, v 56, pp 55-59 September 1948.

8. Militz, R. O.; Spessard, D. R.; Zisman, W. A., *"A Summary of Progress in Developing Non-Flammable Fluids for Use in Aircraft"*, Naval Research Laboratory Report P-2944, August 1946.

THE Aldrich Central Hydraulic System illustrated above is installed in a textile belting plant, where it provides hydraulic pressure used in impregnating fabric belts with rubber and in laminating belt sections to produce continuous belting.

By means of the Aldrich-Groff "POWR-SAVR" Controllable Capacity Pump, all of the hydraulic pressure required—*but only that pressure actually needed*—is supplied. This pump automatically controls delivery—in almost direct proportion to demand.

And, by means of the Central System, all hydraulic pressure originates from a single, compact source—affording the least amount of machinery, less maintenance, and quick, easy accessibility. The Aldrich Central Hydraulic System is good engineering—simple, direct, efficient.

For whatever application of hydraulic pressure you may have, and to provide you with pumping equipment that specifically fits your individual requirements—Aldrich builds many types of reciprocating pumps, from the variable stroke "POWR-SAVR" through the constant stroke, constant speed, Inverted Triplex pumps—up to and including the Inverted Nonuplex of 2400 H.P.

For information or for assistance on any pumping problem, write to The Aldrich Pump Company.

Representatives: Birmingham • Bolivar, N. Y. • Boston • Chicago • Cincinnati Cleveland • Denver • Detroit • Duluth • Houston • Jacksonville • Los Angeles New York • Omaha • Philadelphia • Pittsburgh • Portland, Ore. • Richmond, Va. St. Louis • San Francisco • Seattle • Spokane, Wash. • Syracuse • Tulsa

THE ALDRICH PUMP COMPANY

14 GORDON STREET, ALLENTOWN, PENNSYLVANIA

The **FIRST** *Name in Reciprocating Pumps*

New PRODUCTS

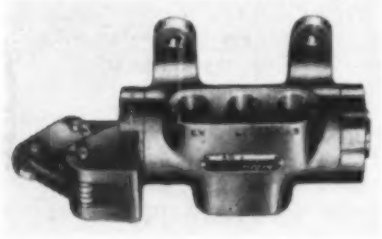
For additional information on any of these products, mark the end key numbers on the card bound in this issue and mail the card.

Four-Way Manual Valve

The Romec Pump Company Div., Lear, Incorporated, announce their Model HV-1661-AG four-way manual hydraulic valve. Designed to be mounted directly over the hydraulic piston-type cylinder, it controls the linear movement of the piston as to direction and speed. Of open center type, with integral relief valve, the valve has an oversize spool with long spindle sections for full flow with low velocity between the ½ in ports. Simple and rugged, the valve is especially suited for such applications as tractor tool actuation where maintenance is at a minimum. *1.*

Control Valves

Modernair Corporation announces the addition of a cam operated model and a foot controlled valve with spring return action to their line of



CV Control valves. This series was specially designed for the control of single and double acting cylinders in pneumatic or fluid circuits. The valve piston is fully balanced, eliminating handle load from pressure; the design permits transmission of full line volume and pressure. Identical housing assembly for all models in the same pipe size permits hand, foot, cam, electrical or pressure pilot operation and conversion from one to another without breaking line connections or dismounting valve. The CV valves are available in ⅜ and ¾ in 18-port sizes. *2.*

Four-Way Air Control Valve

A new three-position, double, four-way air control valve for operating two double-acting air cylinders has been announced by the Logansport Machine Company, Inc. The valve, Model No. 50, is of packless plug-type construction; the brass taper plug is precision ground and lapped into a high tensile cast iron

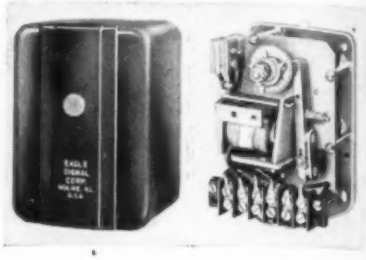
body. Made for foot mounting on any flat surface, the valve may be located in any position on a machine. All working valve parts may be removed without disconnecting air lines; two cylinder ports and an exhaust port are grouped on one side of the valve with two cylinder ports and an intake port on the opposite side; all ports are tapped for ¼ in pipe. *3.*

Hydraulic Valve Solenoid

A hydraulic valve solenoid incorporating a shock absorber is announced by Trombetta Solenoid Co. The shock absorber, designed to take up the shock from the operation of the plunger, can be mounted on the base plate since the solenoid is equipped with a patented loose pole piece. The absorber greatly extends the life of the solenoid according to the manufacturer. Solenoid and coil are built for continuous immersion in any type of oil. The loose pole piece also permits complete welding of the assembly and replacement of the coil. *4.*

Delay Relay

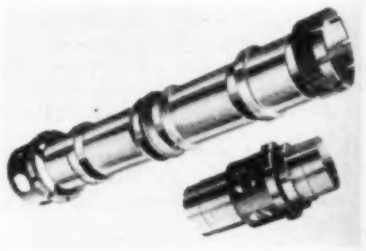
A new delay relay for industrial control circuits is announced by Eagle Signal Corp. The Timoflex delay relay is available in three basic forms for timing the opening or closing of electrical circuits. One form starts timing when the pilot switch is closed; another when the pilot switch opens; and a third when a push button is closed momentarily.



A slow speed synchronous motor with a separate reset coil to release the timing mechanisms provides dependable operation. The timer is available with standard timing scales of 55 seconds, 5½, 27½ or 55 minutes. *5.*

Single-Thread Tube Unions

A lightweight, quick connecting tube union for joining flared tubing is a new development of Roylyn, Inc. Designed for fluid lines where heavy fittings and close line spacing creates serious weight problems and heavy maintenance costs, the Series 1900 Union is used with flared tube ends and consists of five parts: metal seal ring, two sleeves, a threaded clamp



ring and the mating coupling nut. The union is available in 1½, 2, 2½, 3 and 4 in sizes, in steel or aluminum alloy. A typical weight saving of 1½ lbs. in the 1½ in size is claimed. *6.*

CIRCLE NUMBERS ON THE CARD AND MAIL!

Air Operated Vibrators

A new standard line of pneumatically operated vibrators is announced by The Cleveland Vibrator Company. The new Series "SA", featuring low air consumption, minimum number of parts, instant starting with full power, are recommended for such uses as assuring steady flow from hoppers, feeding parts for

(Continued on page 28)

LANDIS TOOL COMPANY

GRINDING MACHINES

The Landis Tool Company, manufacturers of precision grinding machines, utilizes hydraulic circuits for traversing work carriages, traverse speed control, tarry and dressing speed control, selective and adjustable or automatic wheel feed and timing of "spark-out" period. Maintenance data is given for representative machines, selected on the basis of the number of each type in operation.

10 in x 20 in Type H Hydraulic Universal Cylindrical Grinder

General: A small hydraulically operated universal cylindrical grinder which will handle a large variety of small tools and work parts. Operations which can be performed include straight cylindrical, shoulder, taper, face and internal grinding. Maximum swing is 10 inches diameter, maximum length between centers is 20 inches.

Specifications: Catalog I-145.

Hydraulic Circuit: Traverse of the work carriage adjustable from zero to 120 inches per minute by throttle valve control. Hydraulic wheel feed adjustable and operates at carriage reversal. Hydraulic oil filtered. Viscosity compensating valve included in circuit.

Attachments Available: Catalog I-145.

Operation, Service and Parts Books: 10 in x 20 in Type H Universal Service Manual. Submit serial number of machine.

12 in Type LCH Hydraulic Universal Cylindrical Grinder

General: Meets the needs for a full universal grinder of medium capacity for tool room or manufacturing work. Typical grinding operations which can be performed include straight cylindrical, taper, face, internal, work arbors, heavy shafts, small rolls, piercing dies and crank line bearings. Maximum work swing is 12 in diameter; lengths between centers available are 30, 36, 40 and 48 in.

Specifications: Catalog I-44.

Hydraulic Circuit: Traverse of the work table, activated from a twin cylinder arrangement, adjustable from 3 to 144 inches per minute. Tarry of the work carriage is adjustable. Hydraulic grinding wheel feed is selective and adjustable for amount. It may feed at each table reversal or at either end of traverse. Oil is filtered. A viscosity compensating relief valve is incorporated.

Attachments Available: Hydraulic rapid positioning for the wheel base. For mechanical attachments see Catalog I-44.

Operation, Service and Parts Books: 12 in Type LCH Universal Service Manual. Submit serial number of machine.

GRINDING MACHINES

4 in Type H Plain Hydraulic Grinder

General: Supplied with either 12 in or 18 in capacity between centers. These machines are designed for rapid production of a wide range of small work in any quantity within extremely close tolerances. It is suited for either traverse or straight infeed operation. For efficient production, ground diameters should not exceed 1½ in. Cycle selector switches from hand operation to hydraulic traverse or hydraulic infeed operation.

Specifications: Catalog A-49.

Hydraulic Circuit: A vane type pump supplies oil under pressure to a filter and a viscosity compensating relief valve. Traverse, as well as intermittent wheel feed, are both controlled hydraulically. Usually included, extra, is a hydraulic rapid traverse of the wheel head and a hydraulic slow grinding wheel feed. Timing of the "spark-out" period, also hydraulically controlled, occurs after the hydraulic feed stops.

Attachments Available: Catalog A-49.

Operation, Service and Parts Books: 4 in Type H Plain Hydraulic Grinder Service Manual. Submit serial number of machine.

6 in Type CH Plain Hydraulic Grinder

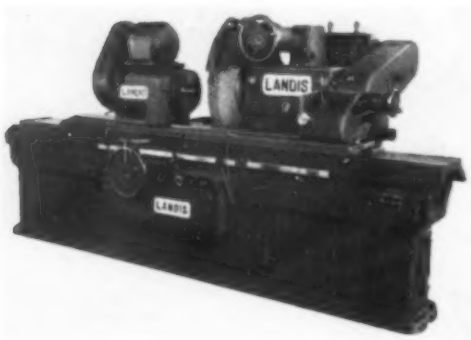
General: A plain grinding machine with large diameter grinding wheel for low cost mass production of small parts. Many have been changed to special purpose grinders by the addition of such parts as angle wheel bases, profile dressers, double wheels, special headstocks, etc. Models raised to swing 10 in diameter work are known as the 10 in LCH type.

Specifications: Catalog B-45.

Hydraulic Circuit: Hydraulic oil is directed through a filter to a viscosity compensating relief valve. Twin traverse cylinders are used to secure exacting control and smooth operation of the traverse. Tarry of the carriage at each end is controlled from a throttle valve. Intermittent wheel feed or continuous straight infeed may be selected by control knobs.

Attachments Available: Catalog B-45.

Operation, Service and Parts Books: 6 in Type CH Plain Hydraulic Grinder Service Manual. Submit serial number of machine.



10 in and 14 in Type CH Plain Hydraulic Grinder

General: For industrial use, this grinder will handle medium weight work pieces. Operations include straight, taper, shoulder and profile grinding. Hydraulic operation speeds the cycle. Either traverse or infeed operations may be selected.

Specifications: Catalog B-43.

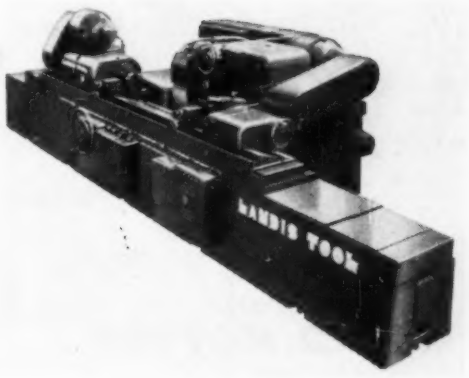
Hydraulic Circuit: A vane type pump and viscosity compensating relief valve are used to keep feeds and speeds constant regardless of hydraulic oil temperature. A two cylinder traverse system is connected to provide maximum speed control and smooth operation. Traverse speed and tarry are both connected by throttle valves.

Attachments Available: Catalog B-43.

Operation, Service and Parts Books: 10 in-14 in Type CH Plain Hydraulic Grinder Service Manual. Submit serial number of grinder.

GRINDING MACHINES

Type F Plain and Roll Hydraulic Grinders



General: This grinder is made in four types. The Type F Plain for 14 in-16 in diameter work; Type FF Plain in 16 in-20 in-24 in swings (also made as a gap grinder which swings 40 in diameter work in the gap); Type FR designates the roll grinder, made in swings of 16 in-20 in-24 in. Lengths between centers range from 36 in to 240 in in the various models. These grinders incorporate all the latest mechanical and hydraulic advances in precision grinders and conform to the latest automotive machine tool standards.

Specifications: Catalog F-48.

Hydraulic Circuit: A hydraulic motor is used to move the carriage. Separate reservoirs and vane type pumps are used for both hydraulic oil and lubricating oil. Separate controls for traverse speed, tarry and hydraulic wheel feed are located on the operator's control desk.

Attachments Available: Catalog F-48.

Operation, Service and Parts Books: Type F Plain, Gap and Roll Service Manual. Submit serial number of machine.

No. 12 Centerless Grinding Machine

General: This grinder is suitable for job lot or production work requiring centerless grinding. Through-feed or infeed operations may be performed. The regulating wheel base may be swiveled so that the infeed taper work may be ground without having to dress a taper on the regulating wheel.

An adaptation of the No. 12 Centerless grinder is the Tool Centerless Thread grinder for the through-feed grinding of threads on any material. Except for the addition of a wheel crushing device and other changes, fundamental hydraulic operation is the same as the No. 12 Centerless.

Specifications: Catalogs T-47 and CTG-47.

Hydraulic Circuit: A hydraulic reservoir compartment contains a pump, viscosity compensating relief valve and oil filter. A piston and cylinder arrangement is used to traverse the regulating wheel base past a fixed diamond for dressing the regulating wheel at the work contact line. The slide of the overhead grinding wheel dresser is moved hydraulically. Direction and rate of both traversing arrangements are controlled from the operator's position.

Attachments Available: Catalog T-47.

Operation, Service and Parts Books: No. 12 Centerless Service Manual. Submit serial number of machine.

Copies of Catalogs and Manuals are available from Landis Tool Company, Sixth and Ringgold Sts., Waynesboro, Pa. The Catalogs and Manuals are the latest issued. Operators of older machines can be certain of getting correct information by giving serial numbers of their machines.

All Landis machines, attachments and accessories are protected by issued and pending United States and foreign patents.

PLENTY of POWER

IN THESE HYDRAULIC PUMPS and FLUID MOTORS

There's plenty of power in Eastern fluid motors and hydraulic pumps. They're tough and compact—ideal where space is at a premium. They're dependable, too. Long life under rugged operating conditions is built-in. An Eastern hydraulic pump or fluid motor in your design is good engineering.

SERIES 100

.1 to 5 GPM—Drive speeds up to 3450 RPM. Working pressures up to 1000 PSI. Average volumetric efficiency: 90%. Average model weight: 1.65 lbs.

Lightweight construction is obtained through use of aluminum housings and nitralloy gears and shafts. Each unit is factory pre-tested for precision and operating efficiency.

WRITE FOR FULL DETAILS

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INDUSTRIES, INC.
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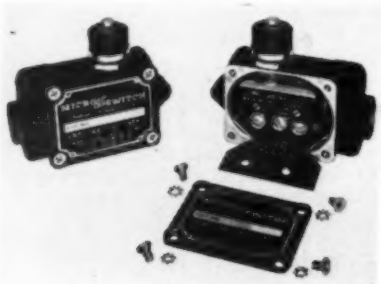
NEW HAVEN 6, CONNECTICUT

(Continued from page 24)

assembly, vibrating tables used in product packaging, fatigue testing complete assemblies and other applications that require constant or intermittent vibration. The vibrators are available in seven sizes with five different mounting arrangements. *7.*

New Micro Switch

A new rugged, enclosed switch designed especially for severe service in industrial use, the BAF1-2RN,



has been announced by Micro Switch. The switching element is the new high capacity type "A" basic switch with steady state current rating of 20 amperes and inrush capacity of 75 amperes at voltages to 460 volts, ac. A newly designed die cast aluminum housing offers unusual protection to the switching element; a sturdy overtravel mechanism, built into the housing, insures long life and accurate repeatability of operating point. The new switch is available in either right hand or left hand designs. *8.*

Low-Pressure Shut-Off Valve

New improved models of the Wardan automatic low pressure shut-off valves are announced by the Security Valve Company. The valves incorporate a precision lapped synthetic rubber seat which provides for positive closure. They are recommended for use on gas or fluid lines where closure is desired when pressure fails from any cause. The valve must be manually reset after closure. Sizes from ¾ to 8 in are currently furnished. Models for high pressure use are also available. *9.*

CIRCLE NUMBERS ON THE CARD AND MAIL!

Short-Stroke Dancer Roll

An electronic device, the VSS Short-Stroke Dancer Roll, designed to meet two distinct speed control problems, is announced by The Reliance Electric & Engineering Co. The dancer roll provides constant tension control for loops of material in process. The reactor, mechanically linked to a dancer roll supported by the web of the material between two sections of a machine, will respond to any change in speed relationship, causing output changes to slow or speed up one of the sections to maintain a set speed and tension relationship. The dancer roll can also be used as a speed setting device to control motor speed in proportion to the position of some object or mechanism. *10.*

Hydraulic Vise

A new swivel-type, foot-operated hydraulic vise is offered by The Columbian Vise & Mfg. Co. Operated by two simple foot control pedals, one power, the other release, the opening and closing can be controlled at any point by the operator. An adjustable production stop can be set at any point within the 6 in

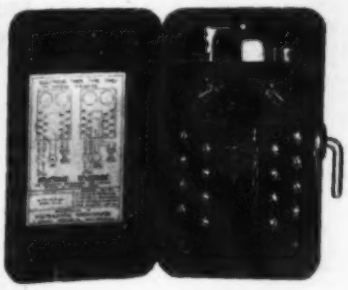
range of jaw opening and the work gripped with one power pedal stroke or held with maximum pressure of 6000 psi with two strokes. *11.*

Solenoid Safety Valve

A new normally open solenoid valve for emergency service has been added to the line of direct operated valves made by The Johnson Corporation. The cap of the new Series No. 6000 valve is provided with an ⅛ in IPT opening; the disc holder is pinned to the valve stem and the direction of flow is reversed, the valve closes with the pressure and flow. The valve stays closed as long as there is a pressure above three pounds on the inlet side, whether the solenoid is energized or not. Bulletin sheet V-7 gives complete data. *12.*

Electronic Timer

A new electronic timer, Type 30HL1, is announced by Photoswitch Incorporated. For automatically timing intervals from 1/20 sec to 4 min, the unit represents an outstanding advance in the field of industrial timing control, according to the manufacturer. The new timer



provides for four basic types of timing—interval, delayed action, automatic repeat and programming, as well as many variations. Although it employs only one tube and one relay, the unit is flexible and the circuit is self-compensating for changes in line voltage. *13.*

Magnetic Contactors

Magnetic contactors in sizes 4 (150 amp) and 5 (300 amp) with entirely new magnetic circuits are announced by Ward Leonard Electric Co. Suitable for general purpose control applications where it is necessary to repeatedly establish and interrupt an electric power circuit, the contactors can be actuated by automatic or manually operated pilot control devices either close by or at a remote point. Size 4 contactors are available with up to five main poles; size 5 can be supplied with two or three main poles. *14.*

Quick Exhaust Air Valve

A new auxiliary air valve which enables cylinders to start their return stroke in a split second, has been announced by Ross Operating Valve Company. The quick exhaust or dumping action of the valve is achieved by mounting the auxiliary valve right at the cylinder and acting as a supplementary valve to the regular operating valve. When the regular valve is in open position and starts to exhaust, it automatically operates the exhaust valve, which "dumps" the air, permitting almost instantaneous start of cylinder return. The new valve is available in ⅜ through 1 in pipe sizes. *15.*

INCREASE THE SERVICE LIFE

OF YOUR HYDRAULIC CIRCUIT COMPONENTS

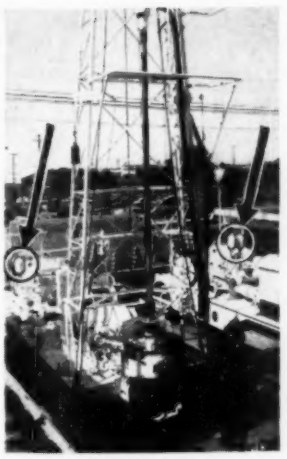
with a GREER ACCUMULATOR

The heart of your hydraulic circuit is the power pump. And like the action of the human heart, the pump sets up pulsations and pressure surges which unless eliminated will cause serious damage to and failure of the pump, pipe lines, valves, bearings, gears and fittings.

The Greer Accumulator provides the simplest and most effective device to smooth out pressure surges and dampen pulsations. Furthermore, the accumulator provides greater operation economy by lengthening the service life of circuit components and eliminating costly repairs.

In addition to the applications illustrated here, the accumulator is ideally suited for boiler feed pumping systems, pressure unloading circuits and hundreds of other similar circuits using hydraulic power.

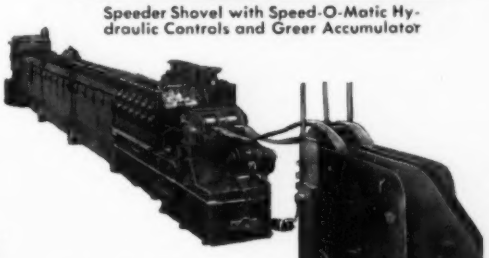
The complete story is covered in our booklet "Accumulators For Fluid Power", free for the asking, write for your copy now!



Oil Drilling Rig

Speeder Shovel with Speed-O-Matic Hydraulic Controls and Greer Accumulator

SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES



"Flying Cut-Off" Sheer and Greer Accumulator

YOUR SYMBOL OF SERVICE

GREER

HYDRAULICS INC.

454 EIGHTEENTH ST., BROOKLYN 15, N. Y.

Useful Literature

The publications listed are available without charge. Mark the initial key number on the card bound in this issue and mail.

1. Motor and Pump Data Sheets . . . Data sheets on hydraulic vane-type fluid motors and pumps have just been issued by Dudco Products Company. Data covers four sizes of pumps that deliver up to 120 gpm and over 1000 psi and four fluid motors that deliver up to 80 hp at 900 rpm and up to 7000 lb-ins torque down to 0 rpm. The manufacturer claims that these pumps and motors add greater flexibility and reduce selling costs.

2. Low Pressure Cylinders . . . Catalog 236 on Low Pressure Cylinders has been issued by Hanna Engineering Works. Construction features, capacities of all standard sizes, dimensional drawings, information on mounting brackets, cylinder cushions and cylinder selection data are given. Designed for operation up to 110 psi, minor modifications make them suitable for operation at higher pressures, depending on cylinder diameter and whether air, oil or water is the operating medium. Diameters from 1½ to 14 in are standard; 16, 18 and 20 in cylinders can be furnished with standard mounting arrangements.

3. Bellows-Type Shaft Seal . . . A four-page bulletin issued by Crane Packing Company describes the John Crane Bellows-Type Shaft Seal, the mechanical seal for centrifugal and rotary pumps, gear boxes and many other industrial applications. Advantages, construction and operation of the seals are listed. A table of minimum dimensions and multicolor diagrams of typical applications are given.

4. Air Control Valves . . . The Marton Air Valve Division, Lehigh Foundries, Inc., show three of their valves in a 4-page circular being mailed to their customers. A four-way combination valve which combines valve, gauge, regulator, lubricator and strainer is featured. The packless, quick-opening, hand-operated air control valve is also available separately. The third unit shown is a delayed action valve for positive operation at pressures from 20 to 200 psi. Standard dimensional drawings are shown.

5. New Cylinder Catalog . . . Anker-Holth Manufacturing Co. has issued a new loose leaf assembled catalog on their complete line of air and hydraulic cylinders, air valves, chucks and collets and new hydraulic pump. Sections are devoted to non-rotating air cylinders, both tie rod and no tie rod types, non-rotating hydraulic cylinders, rotating air and hydraulic cylinders, air or hydraulically operated chucks, 3- and 4-way air control valves, regulating valves and accessories. The new supercharged 3000 psi hydraulic pump is also described.

6. Helicoid Gage Bulletin . . . A 16-page Bulletin on the helicoid gage is available from the Helicoid Gage Division, American Chain & Cable Company, Inc. The helicoid movement, an American development introduced in 1941 and widely used by the Navy during the war, replaces the ordinary gage movement with spur gear teeth. Design, construction and advantages are fully described. Case designs, standard dials and accessories are shown.

7. How to Solve Pumping Problems . . . This very simple, practical and directly useful bulletin on rotary pumps has been published by Geo. D. Roper Corporation. The different steps to follow in selecting the proper pump are explained in simple language. Information on installing rotary pumps, locating trouble and on the care of the pump are included as well as a complete set of essential technical data tables. All problems are worked out in detail.

8. Steam Fan Heater . . . Bulletin No. 109, just released, describes the new Niagara High Pressure Steam Fan Heater offered by Niagara Blower Company. The simple, patented Niagara dual coil system is installed in a standard fan heater. Both sensible and latent heat of high pressure steam are fully utilized. The unit does away with complex piping, pressure-reducing stations and expensive accessories of a conventional high pressure system, savings in installation and operating costs.

9. Alumnium Air Cylinders . . . A 4-page Bulletin, issued by The Cushman Chuck Co., describes the high speed aluminum air cylinders they make for power chuck operation. Cylinder bodies of high tensile strength alloy forgings are furnished with lapped bores; cylinders are statically balanced, have larger air ports and new positive pressure-balanced air seal and lock. They are available in sizes 3½ to 12 in for applications at speeds up to 500 rpm.

CIRCLE NUMBERS ON THE CARD AND MAIL!

10. Ostuco Tubing . . . The catalog Ostuco Tubing and Facilities, issued by The Ohio Seamless Tube Co., describes the manufacture, advantages and applications of the mechanical seamless carbon and alloy tubing they make. This tubing is available in sizes ranging from ¼ in OD x 22 ga up to 7 in OD. Data on aircraft seamless and electric resistant welded tubing are included.

11. Duplicating Attachments . . . A four page bulletin issued by Walker Hydraulic Duplicator Co. shows a representative group of one, two and three dimension hydraulic duplicators in operation on diverse types of machining equipment. A self-contained hydraulic circuit operates a tracer which duplicates from a master model, pattern or template. The units may be installed on practically every type of machine tool and on many special purpose machines.

12. Compressor Supplement . . . Supplement "B" to Bulletin 726-4 describes the larger sizes (700 to 1500 hp) of the Class O-CE horizontal duplex, motor-driven compressors built by Chicago Pneumatic Tool Co. These compressors, similar to the smaller compressors described in Bulletin 726-4, have additional features including removable "wet" cylinder liners, light-weight cast iron pistons fitted with special wear

rings, balanced five-step regulation, force feed lubrication and shim-adjusted, parallel-fitted bronze crosshead shoes.

13. Air Filters . . . Bulletin 105, available from R. P. Adams Company, Inc., describes their series of Poro-Stone Air Filters. Equipped with a centrifugal separator and an automatic trap, the filter removes liquid oil, moisture and solid pipe scale. The filters are available in pipe sizes from ⅜ to 4 in and capacities from 15 to 700 cfm at 80 to 125 pounds.

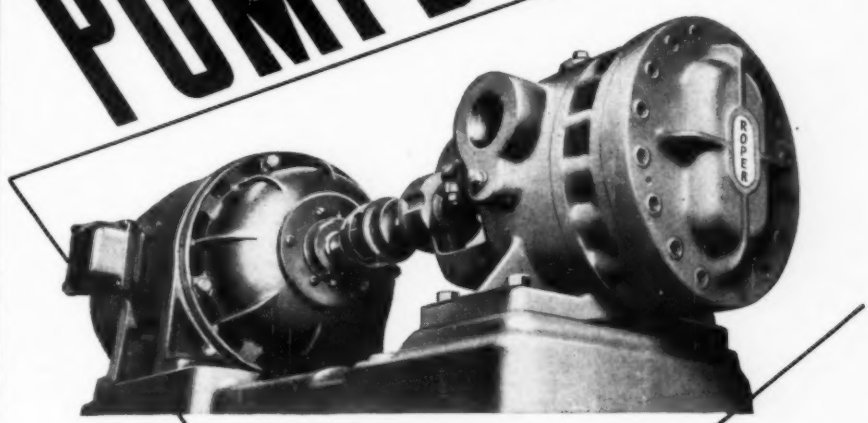
14. Infeed Attachment Bulletin . . . The Bellows Co. has just released their new Bulletin No. IF-47, "Model BFG-5 Infeed Attachment". Designed especially for installation on Cincinnati No. 2 centerless grinders, the unit consists of an electrically controlled air motor equipped with a rack and pinion gear, a Hydro-Check, time controls, lubro unit and start and stop switches, assembled in a compact unit. The infeed attachment can be adapted for other uses where precision control of feeding rate and dwell is required.

15. Midget Relays . . . Data Section 2100, an 8-page Bulletin on Midget Relays, has been issued by Struthers-Dunn, Inc. The Bulletin supersedes their previous publication on the same subject. Numerous design variations of the complete line are shown; contact ratings, standard construction specifications, mountings, covers and enclosures are detailed. A new price list accompanies the Data Section.

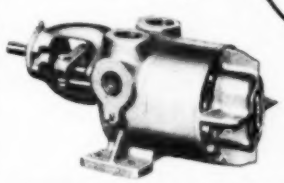
16. Klosure Oil Seals . . . Models 53 and 63, which supplement but do not replace older seals, are described in a 40-page manual issued by The Garlock Packing Company. Model 53 Klosure consists of a metal case, a metal adapter, a metal spring and synthetic rubber seal; model 63 consists of a metal case, fibrous composition adapter or filler ring, spring and molded synthetic seal. Both are available in a full size range.

17. Hydraulic Cylinders . . . Bulletin 110, being distributed by Hannifin Corporation, describes the improved Series N, double-acting hydraulic cylinders they offer. Full information on construction, mounting types, ratings, engineering data,

PUMPS FOR ALL INDUSTRIES

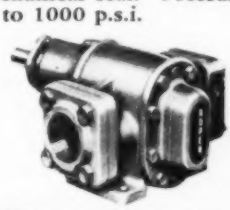


by ROPER



SERIES F pumps — with four-port design offering 8 optional piping arrangements —are used with all kinds of clean liquids. Standard or bronze fitted; packed box or mechanical seal. Up to 300 p.s.i.; 1 to 300 g.p.m.

SERIES H pumps are used for hydraulic mechanisms; other places where high pressures are required. Packed box or mechanical seal. Pressures up to 1000 p.s.i.



SERIES K pumps are used for hydraulic service, fuel transfer, or fuel supply. Roper Venturi suction and discharge principle. Packed box or mechanical seal. 150 p.s.i.; ¾ to 50 g.p.m.

Dependable Roper Rotary Pumps are built in a wide range of sizes and capacities to take care of diversified needs in industry. Simple, compact design permits optimum performance and smooth, quiet operation under sustained pumping runs . . . maximum suction qualities — in all types of liquid transfer work — give high volumetric efficiency with low power requirements.

Whether you work with thin or thick liquids, there is a Roper available to handle virtually any clean liquid. Pumps are standard fitted and bronze fitted — have capacities from ¾ to 300 g.p.m. — pressures up to 1000 p.s.i. — speeds up to 1800 r.p.m. — mountings and drives for every practical need.

Investigate Roper Pumps and their adaptability to your installation. This is the *quick, sure* way to solve your pumping problem.

Write for Descriptive Literature

SERIES 3600 pumps ase used for general purpose work handling thin or thick liquids. Standard or bronze fitted; with or without built-in relief valve. 40 to 200 g.p.m.

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705 Blackhawk Park Ave., Rockford, Illinois, U. S. A.

ROPER Rotary Pumps

BUILDERS OF PUMPS FOR MANUFACTURING, MARINE, PETROLEUM, AND PROCESS INDUSTRIES

dimensions and accessory information is included. Twelve sizes 1 to 8 in bore, cushion and non-cushion type heads for operation to a maximum of 1500 psi working pressures are in the line.

18. Seamless Metal Hose Manual . . . A 72-page manual, issued by Packless Metal Products Corporation, gives complete information on the regular line of seamless flexible bronze hose from ¼ to 10 in ID made by them. In addition to technical information, application photographs and installation suggestions, flanges, connectors, couplings and assemblies are given detailed attention. A self-flaring coupling for plastic tubing, claimed to be the only one, is also described.

19. Rotary Union . . . Twenty-page Catalog No. 500, issued by Perfecting Service Co. describes the design, construction and installation advantages of the all purpose, ball-bearing rotary union made by this company. Photographs of typical applications, Engineering data on plain and syphon rotary unions are given. Recommended for water, oil or air applications, the unions are available in standard pipe sizes ½ to 3 in.

20. Mercury Manometer . . . A new type, high-accuracy, mercury manometer, designed for flow, liquid level and differential pressure measurement, is announced by Taylor Instrument Companies. Designated Model 1500, the new manometer operates at 1500 psi and is available in ranges of 10 to 400 inches of water. It is built for use on indicating, recording or controlling instruments; two manometers can be mounted on a single case for recording two flows or ratio flow control. Features include greater energy output, pressure tight bearing, positive overrange protection, leakless damping adjustment and interchangeable range chambers.

21. Dual Purpose Hydraulic Oil . . . Lubeway, a combination hydraulic fluid and way lubricant developed for machine tools and other industrial equipment designed to provide for the lubrication of ways and slides from the hydraulic reservoir is described in a new 8-page bulletin just released by Sun Oil Company. The development, testing and experience of a leading machine tool manufacturer are given. Lubeway is available in 150 and 300 VI grades.

22. Pressure Control Valves . . . Bulletin 45-34a, issued by Vickers Inc., covers the "Hydro-Cushion" type pressure control valves made by this company. Specifications, schematic diagrams and installation drawings of unloading, sequence, overload relief and counterbalance valves in ¼ to 1½ in pipe sizes in threaded and gasket type connections are included.

23. Compressed Air Separator Literature on a new separator designed to remove the last trace of oil, moisture and dirt from compressed air at the point of use, is announced by James A. Murphy & Co. Designed for installation in the pipe line just ahead of the point of delivery, the unit comprises a strainer cartridge, an expansion chamber and moisture collector or sump. The removable cartridge contains two cotton felt absorbent pads, packed between perforated brass baffles. The unit is available in two sizes.

A SPECIFIC METAL BEST SUITED TO EACH OF YOUR PARTS

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THE Engineered BRONZE

THRUST PLATES • BEARING PLATES • SEALS • CONNECTING RODS •

Regardless of size or quantity, let us make recommendations on your requirements — best locations for oil grooves, etc. Write today, sending blue prints, conditions of operation and other data.

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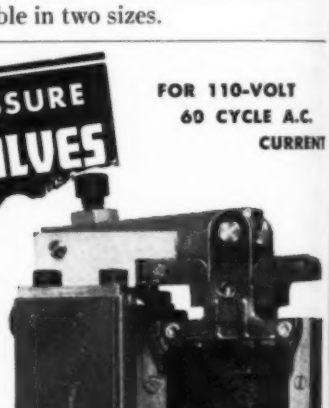
NEW HIGH PRESSURE SOLENOID VALVES

FOR 110-VOLT 60 CYCLE A.C. CURRENT

Features

- Rugged compact construction
- 3000 P.S.I. operating pressure
- Continuous duty
- Poppet design eliminates leakage
- May be mounted in any position
- Impregnated coils resist moisture and condensation



Waterman High Pressure Solenoid Valves are inexpensive, compact units designed for continuous duty in hydraulic systems where pressures are as high as 3000 P.S.I. Poppet type construction gives positive sealing against internal leakage. Impregnated oil resistant coils make these valves suitable for mounting in oil reservoirs. In many cases this feature eliminates costly piping and makes possible the construction of smaller, more compact hydraulic power units. Available in ⅜" pipe size. Electrical requirements are 110 volt—60 cycle A.C. current.

WATERMAN ENGINEERING Company
721 CUSTER AVENUE • EVANSTON, ILLINOIS

Applied HYDRAULICS DIGEST

Abstracts, summaries and listing of articles on hydraulic and associated applications in industry; reports on prepared papers, talks and discussions pertinent to the hydraulics field.

Non-Flammable Hydraulic Fluids

C. M. Murphy and **W. A. Zisman,** Paper prepared for delivery at Annual Convention of the American Society of Lubricating Engineers, New York, April 11-13, 1949.

From an abstract of the paper published in the April issue of *Lubricating Engineering*.

Mr. Murphy is senior research chemist and Mr. Zisman head of the Lubricants Division of the Naval Research Laboratory. After outlining the properties required of hydraulic fluids, the need for less inflammable fluids for certain commercial and military applications is pointed out. The paper summarizes the methods of evaluating the flammability of fluids and the conclusions as to the relation of flammability to chemical composition are presented. Fluids reviewed include petroleum oils, carboxylic, phosphate and carbonate esters, glycols, ethers, polyglycol ethers, silicones, chlorinated and fluorinated compounds and water-base fluids. A number of promising directions for the synthesis of more suitable organic fluids are stated.

The need for more study on the action of fire-resistant additives like volatile "snuffers" and non-volatile "quenchers" is pointed out. The authors consider it necessary that further study be given the effect of high boiling liquids in the hydraulic fluid range on elastometers in the research and development work on new fluids and suitable packings.

Air Stored in Building Framework

Elton Sterrett, *The Welding Engineer,* v 34, March 1949, pp 40, 41, 45.

The Forsythe Engineering Co. building at Houston, Texas, incorporates hollow tubular framework to provide a storage capacity for compressed air. The structure was formed by mating two 20-foot radius Quonset buildings to give an outside span of 82 feet 4¾ inches at the foundation line. Two side bays with 12 foot

(Continued on page 36)

No Bigger Than Your Fist!
BUT capable of repetitive, extra heavy duty as an automatic shut-off valve for:
Gas
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Refrigerants
Light Oils
Steam (up to 175 psi)
and many other liquids and gases

What do we mean by "repetitive, extra heavy duty"?

We mean that you can cycle this valve at rates up to 400 closings per minute for millions of operations without need for repairs. We mean it can handle pressures up to 250 psi on air and non-corrosive gases . . . up to 175 psi on water, steam, refrigerants . . . on light oils up to 150 psi. We mean that the solenoid coils are Class A insulated for temperatures up to 212° F and high temperature insulated for temperatures up to 450° F. We mean that valve discs close in direction of flow and are of the ASCO Self-aligning form to insure tight-seating under all conditions. One pipe size only—3/8 inch; three port areas—1/8, 5/32 and 1/4 inch.

Yes, our Bulletin 8265 Shut-off Solenoid Valve will provide a lot of repetitive service. It's efficient and durable. In asking for Valve Section 6-V, which gives full details of this valve, tell us about your problem.

ASCO Solenoid VALVES

When in need of Automatic Transfer Switches, Remote Control Switches, Contactors, Relays, and Specialized Electromagnetic Controls, come to us.

Automatic Switch Co.

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Sealing Problems?

The low-cost, dependable solution is the "O" ring seal

GRC "O" Rings

Packing' Seals of Precision

Simplify— your product design, reduce machining operations and provide ease of installation.

• Costs tumble when hydraulic and air operated units are developed to use "O" ring seals.

Adaptable— to materials of your specifications. Tested synthetic and silicone rubber compounds available to meet a wide range of requirements.

• Our laboratory engineers and facilities are at your disposal to develop special application materials.

Proven— by industry-wide acceptance for inclusion in innumerable types of equipment.

• The "O" ring seal is performing a vital function in applications ranging from fountain pens to diesel locomotives.

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Our engineering staff will welcome an opportunity to assist you in applying this modern seal to your product. The answer to your problem will be found in their seven years experience in this field. Send for free "O" ring Catalog "C" illustrating installation data and recommended use practices.

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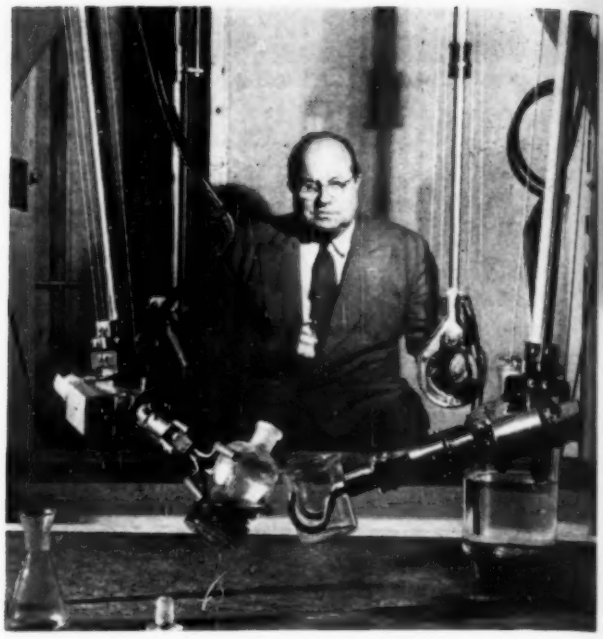

Hands Off

Handling

SINCE IT IS OFTEN DESIRABLE OR necessary to handle radioactive materials, as well as equipment exposed to radio activity, this is one safe way to do it. The robot hands simulate all the movements of human hands. Special geared-down electric motors rotate the hands, so that in addition to doing such operations as pouring liquids from one receptacle to another, slicing an orange, lighting a cigarette or writing a name, the robot hands can rotate continuously to do such jobs as unscrewing a nut or boring a hole.

The hands actually extend over a protective eight-foot wall into a radio-active area. The suspended shafts simulate upper arm movements; pivoted motor housings act as "elbows". As in the human hand, the most precise movements are necessary in operating the steel fingers. The movements of the fingers, actually two or three hooks or clamps, are hydraulically actuated, servo controlled, the fluid being conveyed through seamless flexible metal tubing.

The manipulation of the intricate mechanical-electrical-hydraulic circuits is accomplished by both hand-grip and foot pedal controls. The hand-grips may be turned around three axes, causing similar movements of the robot hands up or down, forward or backward or from side to side. The fingers are opened and closed by operation of the pedals, the circuit being similar to that of a standard automotive hydraulic brake system. While it is possible to seize an object with a force much greater than can be exerted by the human hands, a very light touch can be exerted, so as to break the shell of a hard-boiled egg without damaging the contents.

The operator is seated and views his robot hands, eight feet away, with the aid of binoculars and a four-mirror periscope, which looks over the protective wall. The illustration shows John Payne, inventor and General Electric scientist, at the controls. By photographing the mirrors, Mr. Payne seems to be seated immediately in front of the robot hands.

The device, tentatively called a remote-controlled manipulator, was exhibited at the recent 18th Annual Safety Convention Exposition in New York by the G-E Research Laboratory and the Atomic Energy Commission.

THIS WIDE RANGE OF PUMPS MAKES SELECTION EASIER

COOLANT PUMPS
Centrifugal
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LUBRICATING PUMPS
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DIRECT DRIVE OR MOTOR DRIVEN

The wide variety of types and sizes available in Brown & Sharpe Pumps simplifies your selection of the right pump for the job.

Every pump in this line has distinctive features to assure economical, dependable long-life service. All have the same familiar standards of high quality that characterize Brown & Sharpe machine and tool equipment.

Make your selection with the help of our latest pump catalog. It includes illustrations, complete descriptions, installation dimensions and charts showing performance characteristics. Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.

We urge buying through the Distributor

BROWN & SHARPE PUMPS

Just Compare

Denison's Variable-Volume HydrOILic Pumps

WITH ANY OTHER MAKE OF PUMP

PSI UP TO 5000
GPM UP TO 35

COMPARE COST of these Denison Pumps with *any other* variable-volume pumps—even with pumps rated at only *one-half* their capacity. You'll quickly see the advantages of using Denison's 5000 psi pumps, even on your 2500 psi requirements. For little or no extra cost you get the extra efficiency and longer wear of a pump operating at only *one-half* its capacity. And you have reserve capacity if needed. Wherever you need 5000 psi *or less*, you're ahead with a Denison hydraulic pump!

COMPARE CAPACITIES! Denison pumps give you up to full 35 gpm capacity in rugged, compact form. Full pressure range from 0 to 5000 psi available with either hand-wheel, stem or pressure-compensating controls.

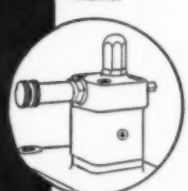
COMPARE QUIETNESS! Quietness of operation is another outstanding feature of these Denison pumps. They reduce noise to a negligible factor!

COMPARE SIZE! The compactness of Denison pumps—makes them easier to adapt to your specific needs. Size for size, they have no equal. Write today for Bulletin P-2.

CHOICE OF CONTROLS

HANDWHEEL CONTROL, for quick, easy manual control of pump delivery.

STEM CONTROL for use with mechanical control of pump volume.



PRESSURE-COMPENSATING CONTROL, for fully automatic control of pressure and volume.

THE DENISON ENGINEERING COMPANY
1166 Dublin Road • Columbus 16, Ohio

DENISON EQUIPMENT for APPLIED HydrOILics

DIGEST

(Continued from page 33)

clearance and a center section with 18½ foot clearance are all supported on 5 inch tubing. Longitudinals and transverse members are also the same size tubing; the combined capacity of the tubing is 470 cu ft—about three times the normal requirement for the shop. A 15 hp, 61 cfm motor driven compressor keeps 100 psi of air in the system. Drains were shop made by flame cutting small openings near the base of columns and welding in a pipe collar or coupling. With the large reserve of air, the carry-over of air proved sufficient on one occasion to shut down the compressor for a complete overhaul without depriving the shop of air.

Industrial Load Cells

Anonymous, *Product Engineering*, v 20, March 1949, pp 111-115.

A clear explanation of the design, function and selection of the three most widely used load cells—devices that transmit changes in applied force into changes in fluid pressure or electric energy, which are then measured on suitable instruments. In applications where simple beam balances or scales cannot be used, load cells are the most reliable method of indication, measurement or control. They are compact, rugged, light in weight, simple to install and operate and are extremely accurate over a wide load range. The types are electric, hydraulic and pneumatic. The electric cell transmits force into changes in electrical potential, which then can be amplified and measured. The hydraulic cell is essentially a refined piston and cylinder in which fluid is compressed in proportion to the applied force, the resultant pressure changes being measured on direct-reading gages or on servomechanism indicators. The pneumatic cell floats the load on an air cushion, indicating on gages the force required. Schematic diagrams and a table of characteristics of load cells are included.

Forty-Seven Causes of Centrifugal Pump Troubles

Igor Karassik and **Roy Carter,** *Operating Engineer*, v 2, March 1949, pp 40-41.

A quick trouble shooting procedure and a check chart of 47 possible causes of troubles. The causes are grouped into suction, system and mechanical troubles.

Farm Horsepower

Anonymous, *Reader's Digest*, v 54, February 1949, pp 118-120.

The original article was published in "Fortune" for October 1948. The fact that the American farmer now has more than three million tractors, double the number in operation in 1940, and 35 million pieces of other farm machinery, adds up to the astounding fact that there is more mechanical power on the farms of America than there is in all our factories. The equipment bought since 1940 totals 30 million horsepower. A sub-

stantial and increasing part of this great power pool is hydraulic power.

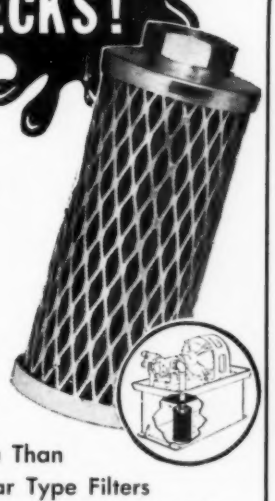
Fewer farmers on larger farms are feeding 40 million more Americans than they did in 1920. By a basic index of civilization, the American farmer has made a remarkable record. Only one in seven U. S. workers provides the nation's food—and helps feed millions of Europeans—while three out of four workers are needed throughout most of the world. However, the mechanization of American farms is far from complete. Farmers still own ten million horses and mules and 60 percent of all farm work is done by hand. Higher wartime income enabled many farmers to buy tractors and other equipment for the first time. The farmer demands trouble-free machines and complains about the slow development of refinements. He himself, suggests many of the changes.

Electronic Position Servo System for Industrial Applications

Paul Glass, *Electrical Manufacturing,* v 43, March 1949, pp 100-105.

This article is significant because it sets up basic design objectives for the application of position servo equipment for industrial equipment and then proceeds to build up a typical circuit, starting with the bare essentials. The author, who is research engineer with Askania Regulator Company, has done a good job in stripping away the "mysterious" from position servos and giving the average engineer a clear picture of the elements of such a system.

DIRTY OIL JAMS! WRECKS!



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2½ Times More Filtering Area Than Equivalent Size Circular Type Filters

This means maximum filtration in less space. Standard 100 mesh (.0050 opening) insert—others range from coarse 30 mesh to fine 200 mesh inserts. Adaptable to meet any filtering problem.

Sump Type in 6 Capacity — 4 Pipe Sizes

—50, 30, 20, 10, 8, or 5 GAL. per minute. Increased capacity easily obtainable with manifold installations.

Write for Catalog No. 103 containing complete engineering data.

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When you equip with RESISTOFLEX ASSEMBLIES you can FORGET YOUR HOSE PROBLEMS

The best hose you can buy is usually the cheapest in the long run. For a top grade hose stands up. It keeps fluid or gas flow under complete control despite constant flexing, vibration, pulsating loads. Such a hose offers greater security against costly replacements, circuit troubles, customer complaints. No wonder so many well-known manufacturers today rely on Resistoflex assemblies!

Four Resistoflex lines, for example, are used in the lubrication circuit of the smoothly operating Reeves Variable Speed Transmission. Even where temperature extremes are encountered, these lines have proved they'll *stay* flexible, and withstand a tremendous amount of flexing.

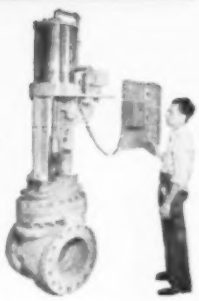
Why not play safe with Resistoflex quality in your own applications? "Line up" with these long-lasting, leakproof assemblies that are impervious to hydraulic fluids, oils, gases. Write for details.

Lubrication system of the Reeves enclosed design Variable Speed Transmission with its four Resistoflex assemblies.

RESISTOFLEX
CORPORATION
Belleville 9, New Jersey
FLEXIBLE HYDRAULIC, OIL, GAS, VACUUM AND REFRIGERANT LINES • COUPLINGS AND FITTINGS

Ledeen heavy duty cylinders helped do this job better

REMOTE CONTROLLED GATE VALVE



APPLICATION—A large gate valve in a chemical plant must be actuated from a remote point. Operator should know position of the valve at all times. A 10" diam. x 12½" stroke Ledeen cylinder provides this control, eliminating travel to the valve as well as heavy manual work in its operation.

OPERATION—Water to power the cylinder is piped from its source at 80 p.s.i., passing through a solenoid operated valve. Solenoid is controlled through switches at a remote panel. Micro switches at top and bottom of piston stroke operate panel signal lights. The gate can be opened or closed instantly and signal lights tell its position at all times.

Perhaps you too have a job that can be improved by Ledeen heavy duty cylinders.

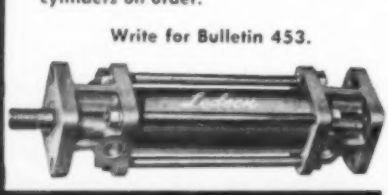
Wherever you have to...

PUSH OR PULL, LIFT OR LOWER, PRESS OR SQUEEZE, TILT OR TURN, OPEN OR CLOSE,

Ledeen heavy duty cylinders, operated by air, oil or water, will do it for you better and surer.

Standard Ledeen Cylinders with rod or head attachments are available from distributors' stock in major cities. Special cylinders on order.

Write for Bulletin 453.



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Ledeen Mfg. Co.

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1600 SO. SAN PEDRO • LOS ANGELES 15, CAL.

POST SCRIPTS OF INDUSTRY

NEWS · VIEWS · TRENDS

Bruce F. Olson, vice president of Sundstrand Machine Tool Co. of Rockford, Ill., was elected president and general manager at a recent meeting of the board of directors. He succeeds his father, the late Hugo L. Olson.

The Hydraulic Equipment Company, Cleveland, announces that J. Norman Paquin has been appointed assistant to vice president Edward J. Hrdlicka. Mr. Paquin was formerly with the Weatherhead Company.

Gits Brothers Mfg. Co., Chicago, has opened a new branch office at Ludington, Mich., from which all operations in the state will be conducted. Frank A. Kovarik will be general sales manager.

Anker-Holth Mfg. Co. announces the appointment of two organizations as representatives: Hanscome-Rogness, Inc., 1030 Second Ave., S., Minneapolis 3, Minn., to represent them in Minnesota and northwest Wisconsin; H. E. Stone Engineering Co., Inc., 2 East Haddon Ave., Oaklyn, N. J., to represent them in Maryland, Delaware, eastern Pennsylvania and southern New Jersey.

Manning, Maxwell & Moore, Inc., Bridgeport, Conn., announces the movement of the former Airex Hydraulics Division from Jersey City, N. J., to Bridgeport. The products made by this division will carry the Manning, Maxwell & Moore, Inc. name hereafter.

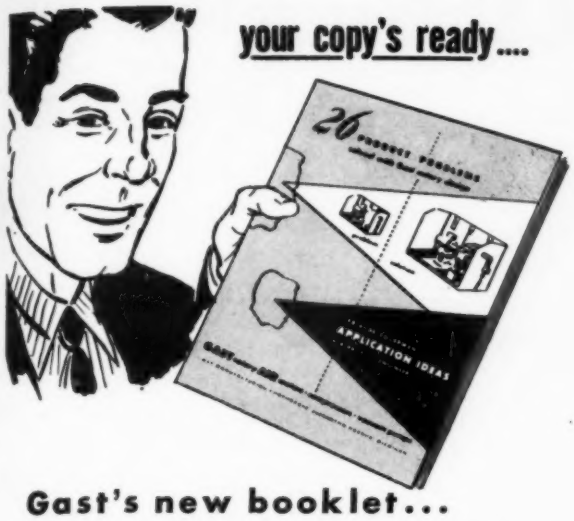
The Hydraulic Subcommittee of the National Machine Tool Builders Association will again function in 1949 with James Robinson, chief engineer of Vickers Inc., as chairman. One member change has been made

(Continued on page 40)

Basic Hydraulics, Questions, Chapter I

1. Give some examples of the application of hydraulic principles in ancient and modern times.
2. What are some of the special features and problems of hydraulic machines?
3. What is meant by the incompressibility of liquids?
4. How does the transmission of forces in liquids differ from their transmission in solids?
5. State Pascal's Law.
6. What effect does the shape of a container have on pressure relations in a liquid?
7. What is *head*?
8. What is meant by *specific gravity*?
9. What is the weight of a column of oil 20 inches high whose cross section area is 10 square inches and which weighs 0.03 pounds per cubic inch?
10. What is the pressure exerted on the bottom of a container by a column of liquid 100 inches high, whose cross section area is 30 square inches and which weighs 0.03 pounds per cubic inch?
11. If the column of liquid in Question 10 stands at sea level, what is the total pressure due to liquid and to atmospheric head at the bottom of the container?
12. What is the difference between pressure and force?
13. How can forces be multiplied in a hydraulic system?
14. A hydraulic jack has a single output piston with an area of 100 square inches. The area of the input piston is 10 square inches. If a force of 5 pounds is exerted on the input piston, how much force will be exerted on the output piston?
15. If the input piston in Question 14 is moved downward 5 inches, how far up will the output piston be moved?
16. A multiple piston jack has two output pistons, each with an area equal to 50 square inches. The input piston, whose area is 5 square inches, is moved downward 20 inches by a force of 100 pounds. How much pressure is developed in the system? How much force will be exerted on each output piston?
17. What is meant by differential areas on a piston?
18. Why are valves necessary in a hydraulic jack?
19. What is the relation between input and output in a hydraulic system?
20. What is meant by *work*? by *energy*?

(For Answer to Problems, see page 40)



Gast's new booklet...

packed with ideas for Product Designers

If you design machinery—or have a part in product development—you'll find this booklet a useful idea-source. It contains data on the use of *air* for many common—and uncommon—applications . . . plus 26 examples of product problems that were solved by putting air to work.

Sooner or later, "Air may be *your* Answer" on a product design problem. ***Write on letterhead for your copy of "Application Ideas".***

GAST ROTARY — AIR MOTORS • COMPRESSORS • VACUUM PUMPS
(TO ONE H.P.) (TO 30 LBS.) (TO 28 INCHES)
GAST MANUFACTURING CORP., 131 Hinkley St., Benton Harbor, Mich.

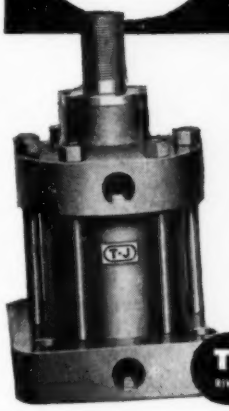
For ANY job that requires

LIFT

PULL

PUSH

You can SAVE LABOR *with* T-J CYLINDERS



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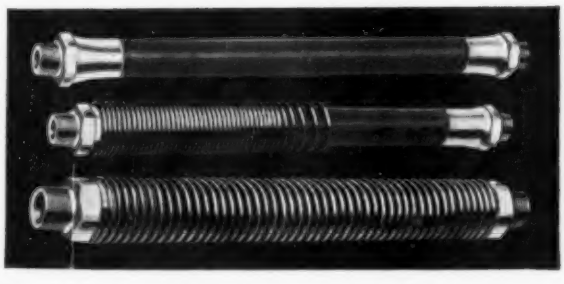

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